

ALBERT R. MANN LIBRARY
CORNELL UNIVERSITY



CORNELL UNIVERSITY LIBRARY



3 1924 101 454 258

ANN
QK
600
M 992
v. 99
2007

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

Volume 99

January–March 2007

CONTENTS

- Taxonomic studies on *Ustilaginomycetes* — 27 Kálmán Vánky 1
Preliminary checklist of the macromycetes of the East and Middle
Black Sea Regions of Turkey Ertugrul Sesli 71
A new species and two new records of *Erysiphe* emend. from China
Tiezhi Liu, Xueliang Bai, Yingchun Wang & Uwe Braun 75
Two new *Alternaria* species from selenium-rich habitats in the
Rocky Mountain Front Range Ami L. Wangeline & F. Brent Reeves 83
Three new lichen species from the French Antilles
Dag Olav Øvstedal & John A. Elix 91
Biogeography and hosts of period wood decay fungi in North Carolina:
species of *Abortiporus*, *Bondarzewia*, *Grifola*, *Heterobasidion*,
Laetiporus, and *Meripilus* L. F. Grand & C. S. Vernia 99
The *Cladoniaceae* of Navarino Island (Prov. Antártica Chilena, Chile)
Ana Rosa Burgaz & José Raggio 103
Cercospora habenariicola sp. nov. and some new records of
cercosporoid fungi from Thailand Jamjan Meeboon, Iman Hidayat,
Chiharu Nakashima & Chaiwat To-anun 117
Taxonomic reassessment of two taxa of helotialean fungi
Wen-Ying Zhuang & Chao-Yang Liu 123
Taxonomic studies of *Alternaria* from China X.
Two new species on *Polygonum* Meng Zhang & Tian-Yu Zhang 133
Taxonomic studies of *Helminthosporium* from China III.
Three new species in Guangdong Province
Meng Zhang, Tian-Yu Zhang & Wen-Ping Wu 137
Taxonomic studies of *Curvularia* from China III.
Two new species on *Poaceae* Meng Zhang & Tian-Yu Zhang 143
Agarics on elephant dung in Kerala State, India
P. Manimohan, K. Agretious Thomas & V. S. Nisha 147
Pyrenomyces of the Russian Far East 2. *Mollicamarops stellata* gen. et sp. nov.
Larissa N. Vasilyeva 159
Macrofungi of Aydın Province, Turkey
Hakan Allı, Mustafa Işıloğlu, & M. Halil Solak 163

[Content continues inside front cover]

ISSN 0093-4666 MYXNAE 99: 1–382 (2007)

For subscription details, availability on microform, and
availability of articles as photocopies or tear sheets, see back cover

- The discovery of *Amanita lilloi* in Brazil
Felipe Wartchow,
Rodham E. Tulloss & Maria A.Q. Cavalcanti 167
- A new species of *Perenniporia* (*Basidiomycota*, *Aphyllorphorales*) from eastern
China
Bao-Kai Cui, Yu-Cheng Dai & Cony Decock 175
- A new species of *Haploporus* (*Basidiomycotina*) from China
Juan Li, Yu-Cheng Dai & Hai-Sheng Yuan 181
- A new species of *Hygroaster* (*Hygrophoraceae*, *Agaricales*) from Colombia
Esperanza Franco-Molano & Carlos Alberto López-Quintero 189
- Two new records of *Entyloma* (*Entylomatales*) from China
Shuanghui He & Lin Guo 197
- New records of pyrenocarpous lichenicolous fungi from Turkey
Mehmet Gökhan Halıcı, Ayşen Özdemir Türk & Mehmet Candan 201
- Entophlyctis luteolus* in the Brazilian Atlantic Rainforest
Carmen L. Pires-Zottarelli, Alexandra L. Gomes
& Cristiane De A. Nascimento 207
- Two new species of *Punctelia* (*Parmeliaceae*) from southern Brazil
Luciana S. Canêz & Marcelo P. Marcelli 211
- First record of the genus *Phlebopus* (*Basidiomycotina*, *Boletales*) in Ecuador
Gastón Guzmán, Flora Castillo-Ayoui, Etelvina Gándara
& Transversin Vivero 217
- A new bluing species of *Psilocybe*, section *Stuntzii*, from New Mexico, U.S.A.
Gastón Guzmán, Lee Walstad, Etelvina Gándara
& Florencia Ramírez-Guillén 223
- Anthracoidea setschwanensis* sp. nov. (*Ustilaginales*) and a new record of
Anthracoidea from China
Lin Guo 227
- Antrodiella semistipitata* (*Basidiomycetes*, *Polyporales*), a new species
from Italy
Annarosa Bernicchia, Leif Ryvarden
& Tatiana Baptista Gibertoni 231
- NATS truffle and truffle-like fungi 15: *Genea balsleyi* sp. nov.
(*Pyronemataceae*), a new hypogeous ascomycete from New Jersey
Matthew E. Smith 239
- The world's second record of *Hyalodictyum colchicum* reported from Turkey
Makbule Erdoğan & Elşad Hüseyin 245
- The genus *Ganoderma* (*Basidiomycota*) in Iran
Mohammad Fata Moradali,
Ghorban Ali Hedjaroude, Hossein Mostafavi,
Mehrdad Abbasi, Shirin Ghods & Abbas Sharifi-Tehrani 251
- Orbilbia vermiformis* sp. nov. and its anamorph
Zefen Yu, Min Qiao, Ying Zhang, H.-O. Baral, & Keqin Zhang 271
- Studies on *Lactarius*: Two new records from Costa Rica and additional
information from Mexico
Leticia Montoya,
Victor M. Bandala & Milagro Mata 279

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

A.R. MANN LIBRARY

APR 26 2007

ITHACA, NY 14853

VOLUME 99,
JANUARY–MARCH 2007

COMPLETE IN ONE VOLUME
CONSISTING OF VI + 382 PAGES INCLUDING FIGURES

EDITOR-IN-CHIEF

LORELEI L. NORVELL

editor@mycotaxon.com

Pacific Northwest Mycology Service

6720 NW Skyline Boulevard

Portland, Oregon 97229-1309 USA

ASSOCIATE EDITORS

NOMENCLATURE EDITOR

SHAUN R. PENNYCOOK

PennycookS@LandcareResearch.co.nz

Manaaki Whenua Landcare Research

Auckland, New Zealand

BOOK REVIEW EDITOR

DAVID L. HAWKSWORTH

MycNova, Calle Aguila 12

Colonia La Maliciosa, Mataelpino

ES-28411 Madrid, Spain

FRENCH LANGUAGE EDITOR

CONY DECOCK

Place Croix du Sud 3

B-1340 Louvain-la-Neuve, Belgium

INDEX EDITOR

KAREN D. GETTELMAN

510 Lake Blvd., Apt. 166

Davis, CA 95616 U.S.A.

EDITORIAL ADVISORY BOARD

WEN-YING ZHUANG, Beijing, China (2003-2008), Chair

DONALD H. PFISTER, Cambridge, Massachusetts, USA (1997-2007), Past Chair

CAROL A. SHEARER, Urbana, Illinois, USA (1998-2009)

SHAUN ROSS PENNYCOOK, Auckland, New Zealand (2005-2010)

SEPPO HUHTINEN, Turku, Finland (2006-2011)

GARY J. SAMUELS, Beltsville, Maryland, USA (1997-2012)

Published by

MYCOTAXON, LTD, P. O. BOX 264

Ithaca, NY 14851-0264, USA

WWW.MYCOTAXON.COM

Printed in the United States of America

© Mycotaxon, Ltd, 2007

MYCOTAXON

VOLUME NINETY-NINE TABLE OF CONTENTS

Taxonomic studies on <i>Ustilaginomycetes</i> — 27	Kálmán Vánky	1
Preliminary checklist of the macromycetes of the East and Middle Black Sea Regions of Turkey	Ertugrul Sesli	71
A new species and two new records of <i>Erysiphe</i> emend. from China	Tiezhi Liu, Xueliang Bai, Yingchun Wang & Uwe Braun	75
Two new <i>Alternaria</i> species from selenium-rich habitats in the Rocky Mountain Front Range	Ami L. Wangeline & F. Brent Reeves	83
Three new lichen species from the French Antilles	Dag Olav Øvstedal & John A. Elix	91
Biogeography and hosts of period wood decay fungi in North Carolina: species of <i>Abortiporus</i> , <i>Bondarzewia</i> , <i>Grifola</i> , <i>Heterobasidion</i> , <i>Laetiporus</i> , and <i>Meripilus</i>	L.F. Grand & C.S. Vernia	99
The <i>Cladoniaceae</i> of Navarino Island (Prov. Antártica Chilena, Chile)	Ana Rosa Burgaz & José Raggio	103
<i>Cercospora habenariicola</i> sp. nov. and some new records of cercosporoid fungi from Thailand	Jamjan Meeboon, Iman Hidayat, Chiharu Nakashima & Chaiwat To-anun	117
Taxonomic reassessment of two taxa of helotialean fungi	Wen-Ying Zhuang & Chao-Yang Liu	123
Taxonomic studies of <i>Alternaria</i> from China X.		
Two new species on <i>Polygonum</i>	Meng Zhang & Tian-Yu Zhang	133
Taxonomic studies of <i>Helminthosporium</i> from China III. Three new species in Guangdong Province	Meng Zhang, Tian-Yu Zhang & Wen-Ping Wu	137
Taxonomic studies of <i>Curvularia</i> from China III.		
Two new species on <i>Poaceae</i>	Meng Zhang & Tian-Yu Zhang	143
Agarics on elephant dung in Kerala State, India	P. Manimohan, K. Agretious Thomas & V. S. Nisha	147
<i>Pyrenomyces</i> of the Russian Far East 2. <i>Mollicamarops stellata</i> gen. et sp. nov.	Larissa N. Vasilyeva	159
Macrofungi of Aydın Province, Turkey	Hakan Alli,	
	Mustafa Işıloğlu, & M. Halil Solak	163
The discovery of <i>Amanita liloi</i> in Brazil	Felipe Wartchow,	
	Rodham E. Tulloss & Maria A.Q. Cavalcanti	167
A new species of <i>Perenniporia</i> (<i>Basidiomycota</i> , <i>Aphyllphorales</i>) from eastern China	Bao-Kai Cui, Yu-Cheng Dai & Cony Decock	175
A new species of <i>Haploporus</i> (<i>Basidiomycotina</i>) from China	Juan Li, Yu-Cheng Dai & Hai-Sheng Yuan	181
A new species of <i>Hygroaster</i> (<i>Hygrophoraceae</i> , <i>Agaricales</i>) from Colombia	Esperanza Franco-Molano & Carlos Alberto López-Quintero	189

- Two new records of *Entyloma* (*Entylomatales*) from China
Shuanghui He & Lin Guo 197
- New records of pyrenocarpous lichenicolous fungi from Turkey
Mehmet Gökhan Halıcı, Aysen Özdemir Türk & Mehmet Candan 201
- Entophlyctis luteolus* in the Brazilian Atlantic Rainforest
Carmen L. Pires-Zottarelli, Alexandra L. Gomes
& Cristiane De A. Nascimento 207
- Two new species of *Punctelia* (*Parmeliaceae*) from southern Brazil
Luciana S. Canéz & Marcelo P. Marcelli 211
- First record of the genus *Phlebopus* (*Basidiomycotina*, *Boletales*) in Ecuador
Gastón Guzmán, Flora Castillo-Ayoui, Etelvina Gándara
& Transversin Vivero 217
- A new bluing species of *Psilocybe*, section *Stuntzii*, from New Mexico, U.S.A.
Gastón Guzmán, Lee Walstad, Etelvina Gándara
& Florencia Ramírez-Guillén 223
- Anthracoidea setschwanensis* sp. nov. (*Ustilaginales*) and a new record of *Anthracoidea*
from China
Lin Guo 227
- Antrodiella semistipitata* (*Basidiomycetes*, *Polyporales*), a new species from Italy
Annarosa Bernicchia, Leif Ryvarden & Tatiana Baptista Gibertoni 231
- NATS truffle and truffle-like fungi 15: *Genea balsleyi* sp. nov. (*Pyronemataceae*),
a new hypogeous ascomycete from New Jersey
Matthew E. Smith 239
- The world's second record of *Hyalodictyum colchicum* reported from Turkey
Makbule Erdoğan & Elşad Hüseyin 245
- The genus *Ganoderma* (*Basidiomycota*) in Iran
Mohammad Fata Moradali,
Ghorban Ali Hedjaroude, Hossein Mostafavi,
Mehrdad Abbasi, Shirin Ghods & Abbas Sharifi-Tehrani 251
- Orbilia vermiformis* sp. nov. and its anamorph
Zefen Yu, Min Qiao, Ying Zhang, H.-O. Baral, & Keqin Zhang 271
- Studies on *Lactarius*: Two new records from Costa Rica and additional
information from Mexico
Leticia Montoya,
Victor M. Bandala & Milagro Mata 279
- Myxomycetes from Sonora, Mexico. 3: National Forest Reserve
and Wildlife Refuge, Ajos-Bavispe
Marcos Lizárraga, Gabriel Moreno,
Martín Esqueda, Alfonso Sánchez & Martha Coronado 291
- New species and new records of *Graphis* from India with partially carbonized exciples
and transseptate ascospores
Bharati Adawadkar & Urmila Makhija 303
- The genus *Campanella* in Western Australia
Neale L. Bougher 327
- Hygrophorus penarioides*, a new species identified using morphology
and ITS sequence data
S. Jacobsson & E. Larsson 337
- Hygrophorus virescens* is transferred to *Hygrocybe*
Leticia Montoya & Victor Bandala 345

Two new species of <i>Corynespora</i> from Guangdong, China	Guang-Min Zhang & Xiu-Guo Zhang	347
Three new species of <i>Corynespora</i> from China	Jian Ma & Xiu-Guo Zhang	353
Taxonomic studies of <i>Sporidesmium</i> from Guangxi, China	Cheng-Kui Shi & Xiu-Guo Zhang	359
Taxonomic studies of <i>Sporidesmium</i> from China	Jian Ma & Xiu-Guo Zhang	367
Indices & Information		
<i>Nomenclatural novelties proposed in volume 99</i>		373
<i>Author index</i>		375
<i>Reviewers</i>		379
<i>Errata</i>		380
<i>Submission to MYCOTAXON</i>		381

PUBLICATION DATE FOR VOLUME NINETY-EIGHT
MYCOTAXON *for* OCTOBER–DECEMBER, VOLUME 98 (1–316 + I–IV)
was issued on March 31, 2007

Taxonomic studies on *Ustilaginomycetes* - 27

KÁLMÁN VÁNKY

vanky.k@cityinfonetz.de

Herbarium Ustilaginales Vánky (HUV)

Gabriel-Biel-Str. 5, D-72076 Tübingen, Germany

Abstract — The smut fungi of *Acanthaceae*, *Eleusine*, *Eragrostis*, *Limnanthemum*, *Paspalum*, *Setaria*, stripe smuts of *Calamagrostis*, and others have been studied. New species include *Entyloma heterothecae*, *Franzpetrakia phaceluri*, *Restiosporium guringaliae*, *Sporisorium myanmarensis*, *Tilletia melicae*, *T. setariae-parviflorae*, *T. setariae-pumilae*, *T. shivasii*, *T. thailandica*, *Ustilago planetella*. New names (*Macalpinomyces patilorum*, *Sporisorium muticae*) and new combinations (*Doassansiopsis limnanthemii*, *Heterodoassansia khandalensis*, *H. ranunculina*, *Sporisorium chrysopogonis-fulvi*, *S. magnusianum*, *S. paspali*, *S. setariae-mombassanae*, *S. tembuti*, *Tilletia beckeriae*, *T. sleumeri*, *T. sphaerocarpa*, *Urocystis pedicularis*, *Ustilago glabra*) are proposed. Twenty-nine taxa are placed in synonymy, *Ustilago panici-latifolii* and *U. pertusa* are excluded from the smut fungi, *Ustilago crameri* is neotypified, and *Doassansia opaca* and *U. eleusines* Syd. are lectotypified. Keys to *Franzpetrakia*, *Sporisorium* (on *Ischaemum*), *Tilletia* (on *Arundinella*, on *Poa*, in vegetative host tissues), the smut fungi of *Acanthaceae*, *Eragrostis*, *Limnanthemum*, *Paspalum*, *Setaria*, and the stripe smuts of *Calamagrostis* are also provided.

The smut fungi of *Paspalum* (*Poaceae*)

Paspalum L., with c. 330 species, predominantly in the New World, belongs to the subfamily *Panicoideae*, tribe *Paniceae*, subtribe *Setariinae* (Clayton & Renvoize, 1986:287). On *Paspalum* at least 25 smut taxa have been published. Some of them were invalidly published, e.g. *Ustilago linderi* and *U. microspora* var. *paspalicola*. Others are not smut fungi, e.g. *Thecaphora inquinans* = *Epicoccum andropogonis*; *Poikilosporium* (*Thecaphora*) *bogoriense* = insect frass. Others were found to be synonyms, e.g. *Sorosporium paspali* and its var. *verrucosum* are *Sporisorium paspali-thunbergii*, and *Ustilago verrucosa* J. Schröt. is *Moesziomyces bullatus*. The host plant of *Ustilago microspora* J. Schröt. & Henn., is not "*Paspalum* sp." but *Stenotaphrum* sp., and the smut is *Ustilago affinis*. The host plant of *Ustilago royleani* is *Digitaria stricta*. On *Paspalum* the following eight smut fungi could be recognised, some of them with doubt:

1. *Moesziomyces bullatus* (J. Schröt.) Vánky, Bot. Not. 130:133, 1977.

Sorosporium bullatum J. Schröt., Abh. Schles. Ges. Vaterl. Cult., Abth. Naturwiss. 1869/72:6, 1869. — Lectotype on *Panicum crus-galli* L., Germany, Schlesien, near Lignitz [= Poland, Legnica], (design. by Vánky, 1977:133) IX.1869, G.W. Schneider, HUV 2442!; isolectotypes in Rbh., Fgi. eur. no. 1489.

Ustilago verrucosa J. Schröt., in Hennings, Hedwigia 35:214, 1896. (not *U. verrucosa* Vesterg., 1897). — Type on *Paspalum distichum* L., Brazil, Estado de Sta. Catharina, Itajahy, I.1886, E. Ule 1619, HBG! (syn. nov.).

Tolyposporium evernium Syd., in Sydow & Ahmad, Ann. Mycol. 37:443, 1939. — *Tolyposporidium evernium* (Syd.) Thirum. & Neerg., Friesia 11:180, 1978('1977'). — Type on *Paspalum distichum* L., Pakistan, Punjab, Akalgarh, VIII.1938, S. Ahmad 105. (syn. by Vánky, 1986a:68).

Tolyposporium paspali Langdon, Univ. Queensland Dept. Biol. Pap. 2:4, 1948. — Type on *Paspalum distichum* L., Australia, Queensland, Brisbane, Ashgrove, Enoggera Creek, I.III.1943, R.F.N. Langdon, BRIP 7987; isotype HUV 2481! (syn. by Vánky, 1986a:68).

For further synonyms, description, literature and illustrations see Vánky, 1994:163-166.

On *Poaceae*: *Echinochloa*, *Leersia*, *Panicum*, *Paspalum*, *Pennisetum*, *Polytrias* and *Uranthoecium* species; Cosmopolitan.

In the short original Latin description of *Ustilago verrucosa*, the sori are in some ovaries, are swollen, brown. The spores are $7-9 \times 8-12 \mu\text{m}$, ellipsoidal or subglobose angular, subolivaceous, with pale brown, thick, densely verrucose wall. The German text states that the spores have cylindrical, flattened or globoid warts. These "warts" are actually the connecting processes between neighbouring spores. The "densely verrucose" spore wall in the original description is misleading. However, all sori in the type specimen contain the same fungus, *Moesziomyces bullatus*.

2. *Sporisorium paspali* (Speg.) Vánky, comb. nov.

MYCOBANK510377.

Basionym: *Ustilago paspali* Speg., Anales Mus. Nac. Buenos Aires, Ser. 2, 6:209, 1899. — Type on *Paspalum* sp., Argentina, near Tucumán, I.1895, C. Spegazzini, LPS 3030 (probably lost).

Ustilago paspali-notati Henn., nom. herb. (in Herb. Holway). — *Sphacelotheca paspali-notati* Henn. ex G.P. Clinton, J. Mycol. 8:140, 1902 [as '(Henn.) Clint. n. sp.']. — *Sporisorium paspali-notati* (Henn.) M. Piepenbr., Ecol. Bolivia 37:54, 2002, comb. invalid, based on a nomen nudum. — Type on *Paspalum notatum*, Mexico, Guadalajara, 15.IX.1899, BPI 165251!; isotype BPI 165250. (syn. by Ciferri & Herter, 1932:534).

Ustilago aristidicola Henn., Hedwigia 47:266, 1908a. — *Sporisorium paspalicola* M. Piepenbr., Flora Neotropica 86:122, 2003. — Type on "*Aristida* sp." (= misnamed *Paspalum brunneum*, det. H. Scholz, B), Brazil, Estado de Bahia, Maracás, IX.1906, E. Ule 3316, HBG 3316!; isotypes BPI 157312!, 196307!, FH (syn. by Vánky, 2001:311, as *Sporisorium microsporum*).

Sori destroying the racemes, transforming them into cylindrical bodies, 1-2 $\times$ 15-40 mm, sometimes comprising also the distal part of the floral axis, at

first covered by a thick, brown peridium which ruptures irregularly, flakes away disclosing the blackish-brown, powdery mass of spores intermixed with groups of sterile cells surrounding a stout, bifurcate or ramified columella corresponding to the raceme axes, often with numerous, short lateral branches at its distal part. *Spores* when mature single, globose, subglobose, ellipsoidal to slightly irregular, $(5.5-)-6-8 \times (6-)-6.5-9(-9.5) \mu\text{m}$, yellowish-brown; wall even, c. $0.5 \mu\text{m}$ thick, finely, densely punctate to verrucose-echinulate, spore profile smooth. *Sterile cells* in irregular groups, collapsed in old specimens, single cells variable in shape and size, $5-12 \mu\text{m}$ long, hyaline; wall thin (c. $0.5 \mu\text{m}$), smooth.

On *Paspalum brunneum* Mez, *P. dilatatum* Poir., *P. notatum* Flügge, *P. plicatulum* Michx., *P. proliferum* Arech., *P. urvillei* Steud., *P. vaginatum* Sw.; N., C. & S. America.

Spegazzini (1899:209), publishing *Ustilago paspali*, gave a very short, incomplete description. He wrote that the spores are small, smooth, in face view discoid, in side view convex-concave. For the spore measurements, Spegazzini gave $6-7 \times 2-2.5 \mu\text{m}$. Later Spegazzini (1925:155), based on material collected around La Plata, on *Paspalum dilatatum*, modified his description of this smut, giving $6-8 \mu\text{m}$ for the spore measurements and saying that some of the spores are minutely echinulate. Ciferri & Herter (1932:534) considered *Ustilago paspali* to be a synonym of *Sphacelotheca microspora* (Henn.) Cif. They considered that the shape and size of the spores, given by Spegazzini in his original description, are caused by observation and measurements of old, dried and shrivelled spores.

This smut fungus has been misnamed *Ustilago microspora* J. Schröt. & Henn. (*Sporisorium microsporum* (J. Schröt. & Henn.) M. Piepenbr.). Piepenbring (2002a:54) demonstrated that the host plant of the type is not „*Paspalum* sp.” but *Stenotaphrum* sp., and the fungus is *Ustilago affinis* Ellis & Everh. Consequently, the next valid name should be applied for this smut, which is Spegazzini's *U. paspali*, belonging to the genus *Sporisorium*.

3. *Sporisorium paspali-thunbergii* (Henn.) Vánky, Publ. Herb. Ustilag. Vánky (HUV) 3:9, 1986.

Ustilago paspali-thunbergii Henn., Hedwigia 43:140, 1904. — *Sorosporium paspali-thunbergii* (Henn.) S. Ito, Trans. Sapporo Nat. Hist. Soc. 14:94, 1935. — Type on *Paspalum thunbergii*, Japan, Honshu, Nikko, IX.1902, S. Kusano 373.

Sorosporium paspali McAlpine, The smuts of Australia:180, 1910. — Type on *Paspalum scrobiculatum*, Australia, Queensland, coll. F.M. Bailey (syn. by Ito, 1935:94).

Sporisorium paspali var. *verrucosum* Thirum. & Pavgi, Mycopathol. Mycol. Appl. 7:283, 1956. — Type on *Paspalum scrobiculatum*, India, Bihar, Netarhat, 28.VIII.1952, M.J. Thirumalachar, HCIO 20992; isotypes IMI, HUV 17295! (syn. nov.).

Sori destroying the whole inflorescence, long cylindrical, $1.5-3(-4) \text{ mm} \times 5-15 \text{ cm}$, often twisted, partly hidden by the terminal leaf sheath, at first covered by a thick, greyish to brown peridium which ruptures irregularly, flakes away disclosing the blackish-brown mass of spore balls and spores surrounding a

long, filiform, often undulate columella, sometimes with short lateral branches on its distal part. Rarely, the sori are restricted to the spikelets only. *Spore balls* globose, ovoid, to long ellipsoidal or slightly irregular, $25-40 \times 30-60 \mu\text{m}$, dark reddish-brown, composed of (5-)8-40 or more? spores which separate easily. *Spores* subglobose, ellipsoidal, usually slightly subpolyhedrally irregular, $(8-9-12(-14.5) \times (10.5-)13-17(-20) \mu\text{m}$, reddish-brown; wall uneven, thickest at the angles, $0.5-1.5(-2) \mu\text{m}$, from apparently smooth to punctate or finely, densely verruculose, especially on the free surface of the spores, spore profile smooth. *Sterile cells* absent.

On *Paspalum conjugatum* P.J. Bergius, *P. dilatatum* Poir., *P. orbiculare* G. Forst., *P. scrobiculatum* L., (*P. commersonii* Lam.), *P. thunbergii* Kunth; Africa, S. & E. Asia, Philippines, Australia, Hawaii.

There are variations in the spore measurements between different collections, even on the same host plant from the same country, e.g. spores on *Paspalum orbiculare* L. from India may have a length of $10.5-14.5 \mu\text{m}$ or $12-19 \mu\text{m}$. However, soral and other spore characters are identical, hence I am considering the difference in spore measurements as variation within the same species.

In the original description of *Sorosporium paspali*, the spores are given as smooth. (McAlpine 1910:180). The very fine verrucae, especially on the free surface of the spores, were not seen by McAlpine. In several specimens, collected in India, these were noticed by Thirumalachar & Pavgi (1956:283), who considered the fungus to be a new variety. Study of the type of *Sorosporium paspali* var. *verrucosum*, revealed that it is identical with *Sorosporium paspali* = *Sporisorium paspali-thunbergii*.

4. *Tilletia rugispora* Ellis, J. Mycol. 7:275, 1893.

Type on *Paspalum plicatulum*, USA, Texas, Brazos Co., College Station, 1889, T.L. Brunk. Topotypes in Ellis & Ev., N. Amer. fgi. no. 2704, HUV 2376!

Tilletia ulei J. Schröt. & Henn., in Hennings, Hedwigia 35:218, 1896. — Type on *Paspalum* cfr. *scrobiculatum*, Brazil, St. Catharina, coll. E. Ule 1616. (syn. by Schröter, in Hennings, 1896:218).

Sori in ovaries, rather inconspicuous, showing between the spreading floral envelopes as subglobose to ovoid, $1-1.5 \times 1.5-2 \text{ mm}$ bodies covered by the pericarp which ruptures irregularly disclosing the black, powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid, broadly ellipsoidal, occasionally irregular, $17-22 \times 18.5-24(-26) \mu\text{m}$, yellowish- to reddish-brown, provided with conical $1.5-3 \mu\text{m}$ high warts. In surface view, the bases of the warts give the illusion of irregular, polyangular areolae. *Sterile cells* variable, mostly irregular to occasionally subglobose or lacrymiform, $15-27(-33) \mu\text{m}$ long, subhyaline, content granular; wall $3-5.5 \mu\text{m}$ thick, indistinctly laminated. Intermediate forms ("immature spores") subhyaline, pale yellow or golden-brown, sparsely papillose. *Spore germination* (Durán 1987:162, 192, Pl. 88)

results in holobasidia producing apically many mononucleate basidiospores which may fuse in pairs.

On *Paspalum convexum* H. & B., *P. floridanum* Michx., *P. paniculatum* L., *P. plicatulum* Michx., *P. scrobiculatum* L., *P. virgatum* L.; N., C. & S. America. Introduced to New Zealand (eradicated).

5. *Ustilago holwayana* Henn., in Holway, Bot. Gaz. (Crawfordsville) 28:274, 1899.

Type on *Paspalum velutinum* (= misnamed *P. cf. tenellum* A. Chase, in Zundel, 1953:166), Mexico, Michoacan, Patzcuaro, 19.X.1898, E.W.D. Holway, BPI 160912, BPI 160913! (ex Herb. Holway; scanty material).

Sori destroying the whole inflorescence, long cylindrical, 2 cm or more in length, first covered by a pale grey peridium which ruptures disclosing the dark brown, powdery mass of spores surrounding remains of inflorescence as a columella. *Spores* ellipsoidal, ovoid, rarely subglobose or slightly irregular, $11-14.5 \times 13-16 \mu\text{m}$, medium dark yellowish-brown; wall even, $1-1.5 \mu\text{m}$ thick (including ornamentation), prominently, moderately densely echinulate, spore profile serrate. *Sterile cells* absent.

On *Paspalum tenellum* Willd. (as *Paspalum velutinum* Trin. ex Nees = *P. urvillei* Steud.); N. America (Mexico). Known only from the type collection.

The host plant of *Ustilago holwayana* is uncertain. Originally, it was given as *Paspalum velutinum*. According to Chase (Zundel 1953:166), it is not *P. velutinum*, it may be *P. tenellum*. The very scanty type specimen I have seen, does not permit a host plant identification.

6. *Ustilago paspali-dilatati* Henn., in Brefeld, Unters. Gesamtgeb. Mykol. 12:122, 1895.

Type on *Paspalum dilatatum*, Brazil, near Blumenau, coll. Möller.

Sori destroying the whole inflorescence. *Spores* large, $12-15 \mu\text{m}$, without ornamentation. *Spore germination* (Brefeld, 1895:123, Pl. VII, figs. 23, 24) results in 4-celled basidia producing large basidiospores or, after conjugation, hyphae.

On *Paspalum dilatatum* Poir.; S. America (Brazil).

The original description of this species is very short and incomplete (see above). No material was available for study.

7. *Ustilago schroeteriana* Henn., Hedwigia 35:215, 1896.

Type on *Paspalum* sp., Brazil, St. Catharina, near Itajahy, XI.1885, E. Ule 1615. Holotype in HBG; isotypes NHES, BPI 166243, 166244, 166245, 194460, HUV 16460!

Ustilago eriochloae L. Ling, Lloydia 14:103, 1951. — Type on "*Eriochloa punctata* (L.) Desv." = misnamed *Paspalum* cf. *paniculatum* (teste M. Piepenbr., 1996:134), Costa Rica, Turrialba, 29.IX.1947, F.L. Wellman, BPI 160383! (syn. by Piepenbring, 1996:136, confirmed).

Tilletia paspali Zundel, Mycologia 23:299, 1931. — Type on *Paspalum millegranum*, Brazil, Bahia, Mata de São João, 3.I.1925, A. Chase 8140½, BPI 60385 = 195169! (syn. by M. Piepenbring, 2003:184, confirmed).

Sori usually destroying all spikelets of an inflorescence, c. $1 \times 1\text{--}2$ mm, sometimes extending to the raceme rachis, olivaceous- to dark brown, powdery, finally remaining behind only remnants of host plant tissues on the raceme axis. *Spores* globose, subglobose, ovoid to broadly ellipsoidal, $12\text{--}18.5 \times 13.5\text{--}20$ μm , yellowish-brown; wall even, $1\text{--}2$ μm thick, moderately densely punctate-verruculose, spore profile smooth to finely wavy.

On *Paspalum botteri* (E. Fourn.) Chase, *P. conjugatum* P.J. Bergius, *P. conspersum* Schrad. ex Schult., *P. costaricense* Mez, *P. intermedium* Munro ex Morong & Britton, *P. millegranum* Schrad. ex Schult., *P. paniculatum* L., *P. plicatum* Michx., *P. repens* P.J. Bergius (*P. paniculatum* Walter), *P. turritiforme* R.W. Pohl, *P. urvillei* Steud., *P. virgatum* L.; N., C. & S. America.

8. *Ustilago venezuelana* Syd. & P. Syd., Ann. Mycol. 14:73, 1916.

Type on *Paspalum* sp., Venezuela, Rio Cuquenán, II.1910, E. Ule 3333 (type where?).

Sori in the ovaries, totally occupying and destroying the spikelets, soon becoming naked, powdery, dark brown, *Spores* globose or subglobose, $7\text{--}9$ μm in diam., yellowish-brown, densely, minutely verruculose.

On *Paspalum* sp.; S. America (Venezuela).

Material not seen. The type is probably lost. Recollection is desired. Description taken from the original.

Doubtful, invalid or excluded species, or not on *Paspalum*

Juliohirschhornia linderi (Hirschh.) Hirschh., Ustil. Fl. Argent.:530, 1986.

Invalid name, based on *Ustilago linderi* Hirschh., Omagiu lui T. Săvulescu:311, 1959. Invalidly published, no type indicated (ICBN (Vienna) 37.1). — On *Paspalum notatum* Flügge, "*P. paludivagum*" (= ? *Paspalidium paludivagum* (Hitchc. & Chase) Parodi), *P. plicatum* Michx., *P. vaginatum* Sw., *Paspalum* sp., Argentina.

Poikilosporium bogoriense Racib., Parasitische Algen und Pilze Java's, Part 2:39, 1900.

The name *Poikilosporium* Dietel is a synonym of *Thecaphora* Fingerh. The identity of *P. bogoriense* is uncertain. It is not known where the type specimen is deposited. In BPI 179089, there is a specimen under this name, on *Paspalum scrobiculatum* L., Indonesia, Java, coll. M. Raciborski, ex KRA. Its study revealed only insect excrements. However, in the original description, the host plant is given as *Panicum* sp. Raciborski (1900:39) himself doubted that his species belongs to the smut fungi. Further studies are needed to elucidate its identity.

Thecaphora inquinans Berk. & Broome, J. Linnean Soc. Bot 14:94, 1873('1875').

Type on *Paspalum scrobiculatum* L., Sri Lanka [Ceylon], Dolosbagey, V.1868, BPI 179274!

It is *Epicoccum andropogonis* (Ces.) Schol-Schwarz (Vánky, 1990:275).

Ustilagopsis deliquescens Speg., Anales Soc. Ci. Argent. 10:6, 1880.

Type on *Paspalum platense* Spreng., Argentina, „in agro Banaerense“, I-IV.1880.

It is *Claviceps deliquescens* (Speg.) Hauman. Excluded by Hauman-Merck and also others (comp. Farr, 1973:1601).

Ustilago garcesii Zundel, Mycologia 37:372, 1945 (as ‘garcesi’).

Type on “*Paspalum saccharoides* Nees”, Colombia, Valle, Palmira, Estacion Experimental, 13.XII.1940, C. Garces O., in Fungi of Colombia no. 1281, BPI 160488!

It is *Sporisorium panici-leucophaei* (Bref.) M. Piepenbr. (comp. Piepenbring, 2002b:110). The identity of the smut indicates that the host plant, which on the original label is given with a question mark, is most probably *Digitaria insularis* (L.) Fedde (*Trichachne sacchariflora* (Raddi) Nees).

Ustilago microspora var. *paspalicola* Hirschh., Omagiu lui T. Săvulescu:310, 1959. Invalid name (ICBN (Vienna) Art. 37.1).

On *Paspalum dilatatum* Poir., *P. notatum* Flüggé, *P. quadrifarium* Lam., *Paspalum* sp.; S. America (Argentina, Uruguay).

Ustilago royleani Syd., P. Syd. & E.J. Butler, Ann. Mycol. 4:426, 1906.

Type on *Paspalum royleanum* Thwaites, which is a synonym of *Digitaria royleana* (Thwaites) Prain (= *D. stricta* Roth ex Roem. & Schult.), India, Dehra Dun, 10.X.1903, E.J. Butler, HCIO 444; isotypes BPI 166095-166098, HUV 16456!

Key to the smut fungi of *Paspalum*

1. Sori in ovaries 2
- Sori in spikelets, racemes or inflorescence 3
2. Spores 18.5-26 µm long, single *Tilletia rugispora*
- Spores 7-13 µm long, forming permanent spore balls *Moesziomyces bullatus*
3. Sori in whole inflorescence 4
- Sori in racemes or spikelets 6
4. Spores 10.5-20 µm long, punctate-verruculose *Sporisorium paspali-thunbergii*
- Spores 12-16 µm long 5
5. Spores echinulate. *Ustilago holwayana*
- Spores smooth *Ustilago paspali-dilatati*
6. Sori in racemes; sterile cells present; spores 6-9.5 µm long. *Sporisorium paspali*
- Sori in spikelets; sterile cells absent 7
7. Spores 13.5-20 µm long *Ustilago schroeteriana*
- Spores 7-9 µm long *Ustilago venezuelana*

The smut fungi of *Setaria* (Poaceae)

Setaria P. Beauv., in the subfamily *Panicoideae*, tribe *Paniceae*, subtribe *Setariinae*, is a genus of about 100 species, mainly in the tropics and subtropics (Clayton and Renvoize, 1986:290). It is closely related to *Panicum*. It is not surprising that several smut fungi may occur on members of both these genera. The smut fungi of *Panicum* have been revised by me (Vánky, 2005:217-250) and recognised forty-one species. The following *Conidiosporomyces* and *Tilletia* species of *Setaria* were studied earlier (Vánky, 2001:313-319), recognising nine species: 1. *C. ayresii* (Berk.) Vánky, 2. *C. echinospermus* (Ainsw.) Vánky, 3. *C. verruculosus* (Wakef.) Vánky, 4. *Tilletia setariae* L. Ling, 5. *T. setariae-palmifoliae* Mishra, 6. *T. setariae-viridis* Vánky, 7. *T. setariicola* Pavgi & Thirum., 8. *T. thirumalacharii* Gandhe, and 9. *T. zundelii* Hirschh. Two additional new species are described below. Further recognised smut fungi of *Setaria* are:

10. *Macalpinomyces neglectus* (Niessl) Vánky, Mycotaxon 89:106, 2004.

Ustilago neglecta Niessl, in Rabenhorst, Fgi. eur. no. 1200, 1868. — *Sporisorium neglectum* (Niessl) Vánky, Symb. Bot. Upsal. 24(2):119, 1985. — Type on *Setaria glauca* (= *S. pumila*), Austria, Steiermark, near Graz, coll. G. Niessl; isotypes in Rbh., Fgi. eur. no. 1200, HUV 4156!

Erysibe panicorum var. *panici-glauci* Wallr., Flora Cryptogamica Germaniae, 2:216, 1833.

— *Ustilago panici-glauci* (Wallr.) G. Winter, Rabenh. Krypt.-Fl., 2 Aufl., 1(1):97, 1881.

— Type on *Panicum glaucum* (= *S. pumila*), Germany, near Halle.

Sori in all florets of an inflorescence, ovoid, usually acuminate, 2-4 mm in length, partly enclosed by the glumes, covered by a thin, greyish peridium of fungal and host origin which ruptures irregularly to expose the dark brown, powdery mass of spores intermixed with irregular groups of sterile cells. Columella short, ovoid, formed of host tissues and fungal cells. *Spores* subglobose, ovoid, elongated to slightly irregular, $8-11 \times 9.5-14 \mu\text{m}$, medium dark reddish-brown, prominently and abundantly echinulate; wall even, c. $0.8 \mu\text{m}$ thick, spore profile finely serrulate, in SEM the area between the spines with small, rounded, sparsely situated warts. *Sterile cells* in groups or solitary (in some specimens scanty), smaller than the spores ($5-12 \mu\text{m}$ long), globoid or slightly irregular, collapsed in old specimens, hyaline, usually with a light-refractive droplet.

On *Brachiaria brizantha* (A. Rich.) Stapf, *Setaria geniculata* (Lam.) P. Beauv., *S. grisebachii* Fourn., *S. pumila* (Poir.) Roem. & Schult. (*Panicum glaucum* L.; *S. glauca* auct. non (L.) P. Beauv.; *S. lutescens* (Weigel) F.T. Hubb.), *S. liebmanni* Fourn., *S. sphacelata* (Schum.) Stapf & C.E. Hubb., *S. ustilata* De Wit, *S. viridis* (L.) P. Beauv.; Europe, Africa, Asia, Australia, N. & S. America.

11. *Macalpinomyces sharmae* Vánky, Mycotaxon 54:223, 1995.

Type on *Panicum sumatrense*, India.

For description and illustrations see Vánky (1995a:223-225, 2005:220).

On *Panicum sumatrense* Roth ex Roem. & Schult. (*P. miliare* Lam.), *Setaria pumila* (Poir.) Roem. & Schult. (*S. pallide-fusca* (Schum.) Stapf & C.E. Hubb. ex Moss), *S. surgens* Stapf, S. Asia (India), Australia.

12. *Macalpinomyces tanakae* (S. Ito) Vánky, Mycotaxon 69:112, 1998.

Ustilago tanakae S. Ito, Trans. Sapporo Nat. Hist. Soc. 14:87, 1935. — *Sphacelotheca tanakae* (S. Ito) Zundel, Ustil. World:208, 1953. — Type on *Setaria italica* var. *germanica*, Japan, Hokkaido, Ishikari Prov., Maruyama near Sapporo, 24.IX.1927, I. Tanaka.

Sori in scattered ovaries, inconspicuous, hidden by the floral envelopes, ovoid, c. 1.5×2 mm, covered by a brown peridium which ruptures irregularly disclosing the dark reddish-brown, granular mass of irregular groups of spores intermixed with sterile cells. *Spores* subglobose, ovoid to usually subpolyhedrally irregular, $8-10 \times 9-12$ μm , yellowish-brown; wall even, c. 1 μm thick, including the densely situated, evident, c. 0.5 μm high spines. *Sterile cells* single or in small groups, subglobose, ellipsoidal to irregular, collapsed in old specimens, (10-)12-28 μm long, hyaline to pale yellow; wall thin (0.5-1 μm), smooth.

On *Brachiaria brizantha* (A. Rich.) Stapf, *Setaria italica* (L.) P. Beauv., *S. italica* var. *germanica* (Mill.) Schrader, *S. viridis* (L.) P. Beauv.; Africa (Zambia), E. Asia (China, Japan).

13. *Sporisorium kenyanum* M. Piątek, see ADDENDA (this volume, pp. 63–64)

14. *Sporisorium magnusianum* (A.A. Fisch. Waldh.) Vánky, comb. nov.

MYCOBANK 510388

Basionym: *Tilletia magnusiana* A.A. Fisch. Waldheim, Aperçu Syst. Ustil.:47, 1877. — *Sphacelotheca magnusiana* (A.A. Fisch. Waldh.) Cif., Trans. Brit. Mycol. Soc. 18:262, 1934. — Type on *Panicum geniculatum* (= *Setaria geniculata*), no further data are given, probably West Indian Antilles Islands, Guadeloupe. Type probably lost.

Ustilago pamparum Speg., Anales Soc. Ci. Argent. 17:89, 1884, nom. nud.; Bol. Acad. Nac. Ci. Cordoba 11:28, 1887. — *Sphacelotheca pamparum* (Speg.) G.P. Clinton, J. Mycol. 8:140, 1902. — *Sporisorium pamparum* (Speg.) Vánky, in Vánky & Guo, Acta Mycol. Sinica, Suppl. I:234, 1987('1986'). — On *Setaria* sp., Argentina, LPS 3738?, in Fungis Arg. pug. I, no. 4 (as *Ustilago setariae* Niessl). (Syn. by Ciferri, 1934:262).

Ustilago kolaczekii J.G. Kühn, in Rabenhorst., Fgi. eur. no. 3401, 1886. — Type on *Setaria geniculata*, Germany, Berlin, Botanical Gardens, Autumn 1884, P. Hennings (of seeds originating from Chile); isotypes in Rbh., Fgi. eur. no. 3401, HUV 1982! (Syn. by Ciferri, 1934:263).

Sori in all spikelets of an inflorescence, ovoid to short cylindrical, $1.5 \times 1.5-3.5$ mm, comprising the innermost floral organs of which remnants are often present on the covering thick, pale brown peridium. The peridium ruptures irregularly from its apex disclosing the dark brown, semiagglutinated to powdery mass of loose spore balls, spores and sterile cells surrounding a stout, irregular columella of the length of the sorus, often with short thorn-like apical branches. *Spore balls* variable in shape and size, subglobose, ellipsoidal, elongated or irregular, $40-110 \times 50-130$ μm , reddish-brown, composed of tens of spores which separate easily by pressure. *Spores* globose, subglobose, ovoid,

ellipsoidal to slightly irregular, $9\text{--}11.5 \times 9\text{--}14\ \mu\text{m}$; yellowish-brown; wall even, c. $0.8\ \mu\text{m}$ thick, finely, moderately densely echinulate, spore profile wavy to finely serrulate. *Sterile cells* few, solitary, globose to ellipsoidal, $5.5\text{--}14.5\ \mu\text{m}$ long, hyaline; wall c. $0.5\ \mu\text{m}$ thick, smooth.

On *Panicum amazonicum* Scribn. & Merr., *P. fasciculatum* Sw., *Setaria geniculata* (Lam.) P. Beauv. (*Panicum geniculatum* Lam.), *S. parviflora* (Poir.) Kerguelen, *Setaria* sp.; Asia (China), N. America (Mexico, USA), S. America (Argentina).

When Spegazzini (1884:89) published the name *Ustilago pamparum* he failed to provide a description. He only mentioned that “ab *Ustilago setariae* Niessl longe abhorrens”, which cannot be considered a description and a valid publication. The earliest valid name for this smut is *Tilletia magnusiana*. According to Ciferri (1934:262) it is identical with *Ustilago pamparum*. The types of both names are apparently lost. Description above is based on the isotype of *Ustilago kolaczekii* from HUV.

The spores of *Sporisorium magnusianum* are rather similar to those of *Macalpinomyces neglectus*. However, the two are markedly different especially in sorus characters and also in the morphology of the sterile cells.

15. *Sporisorium setariae* (McAlpine) Vánky & R.G. Shivas, Fungal Diversity 14:263, 2003.

Sorosporium setariae McAlpine, The smuts of Australia, etc.:183, 1910. — Type on *Setaria glauca* (= *Setaria pumila* subsp. *pumila*), Australia, Queensland, 20 miles S of Cloncurry, 10.V.1909, G.H. Robinson 203/9, VPRI 2980a; isotypes BRIP 26796, VPRI 2981a, HUV 20121!

Sori destroying some or all spikelets in the inflorescence, ovoid to short cylindrical, $1\text{--}2 \times 2\text{--}5\ \text{mm}$, partly hidden by the floral envelopes, first covered by a pale brown peridium which ruptures from its apex disclosing the black, granular-powdery mass of spore balls and sterile cells surrounding several, rather stout, irregular columellae of the length of the sorus, often with short apical branches. *Spore balls* variable in shape and size, subglobose, ellipsoidal, elongated or irregular, $25\text{--}70\text{--}(110) \times 40\text{--}100\text{--}(170)\ \mu\text{m}$, dark reddish-brown, composed of tens to hundreds of spores which separate by pressure. *Spores* variable in shape and size, subglobose, ellipsoidal to usually subpolyhedrally irregular, dimorphic, $(6.5\text{--})7\text{--}12 \times (7.5\text{--})8\text{--}13\text{--}(14.5)\ \mu\text{m}$; outer spores dark yellowish-brown, wall slightly uneven, $0.5\text{--}1\ \mu\text{m}$ thick, free surface densely, finely verrucose-echinulate, spore profile wavy to finely serrulate; inner spores pale yellowish-brown, wall c. $0.5\ \mu\text{m}$ thick, apparently smooth to finely, densely punctate. *Sterile cells* few, globose to ovoid, $6\text{--}10\ \mu\text{m}$ long, hyaline; wall $1\text{--}2\ \mu\text{m}$ thick, smooth.

On *Setaria apiculata* (Scribn. & Merr.) Vickery, *S. pumila* subsp. *pumila* (*S. glauca* (L.) P. Beauv.), *S. surgens* Stapf; Australia.

16. *Sporisorium setariae-mombassanae* (L. Ling) Vánky, comb. nov.

MYCOBANK510379

Basionym: *Ustilago setariae-mombassanae* L. Ling, Lloydia 16:181, 1953. — Type on *Setaria mombassana*, Nyasaland (= Malawi), Chitala to Samlima Road, 22.III.1949, P.O. Wiehe 69, IMI 34947; isotypes BPI 166391, HUV 17397!

Sori in some spikelets (“ovaries”) of an inflorescence, globoid, 3–4 mm in diam., showing between the outer floral envelopes, first covered by a thick, brown peridium which ruptures irregularly from its apex into lobes, disclosing the dark brown, powdery mass of spores surrounding a short, stout central columella, simple or with 2–3 short apical branches. *Spores* when mature single, globose, subglobose, ovoid to ellipsoidal, 5.5–7 × 6–9 µm, pale olivaceous-brown; wall even, c. 0.5 µm thick, sparsely echinulate, spore profile sparsely, finely serrulate, in SEM between the spines finely verrucose. *Sterile cells* not seen.

On *Setaria mombassana* Herrm.; SE. Africa (Malawi). Known only from the type.

17. *Sporisorium setariicola* (Thirum. & Safeeulla) Bag & D.K. Agarwal, Indian Phytopathol. 54:224, 2001 (as ‘*setaricolum*’).

Sorosporium setariicola Thirum. & Safeeulla, Sydowia 5:439, 1951 (as ‘*setaricolum*’). — Type on *Setaria pallide-fusca* (= *S. pumila*), India, Karnataka, Coorg, Makut, 15.VIII.1950, K.M. Safeeulla, HCIO 23711 (type lost); isotype BPI 180320 (lacking sori).

According to the original description: “*Sori* in ovaries, infecting all the spikelets in the inflorescence and converting them into loose, powdery spore mass, partially enclosed by the glumes. *Spore balls* subglobose to irregular, dark brown to opaque, up to 70 µm in diam. *Spores* firmly united, subglobose to spherical, reddish-brown, 8.5 to 13.5 µ in diam. with a mean of 9.1 µ, epispore moderately thick, verruculose. Spores germinating by promycelium bearing lateral and terminal sporidia.”

On *Setaria pumila* (Poir.) Roem. & Schult. (*S. pallide-fusca* (Schumach.) Stapf & C.E. Hubb. ex Moss), *Setaria* sp.; S. Asia (India).

No specimen of *Sporisorium setariicola* is available in HCIO (D.K. Agarwal, in litt.). The isotype in BPI is lacking sori. Its description is very similar to the description, and may represent a synonym of *Tolyposporium setariicola* Syd. & P. Syd (Sydow & Sydow 1912:77; = *Sporisorium*), type on *Setaria aurea* A. Br., Camerun, Sidderiberg, 30.VII.1909, C. Ledermann 4803. Type where?

18 *Tilletia setariae-parviflorae* Vánky & R.G. Shivas, sp. nov.

MYCOBANK510356.

Typus in matrice *Setaria parviflora* (Poir.) Kerguelen (det. H. Scholz, B), Thailand, Sakon Nakhon Prov., Phu Phan Distr., 27 km SW of Sakon Nakhon, 17°03'02.7" N, 103°58'18.0" E, alt. 279 m.s.m., 20.XII.2005, leg. R.G. Shivas, P. Athipunyakom, S. Likhitekaraj, W. Butranu, C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 20209; isotypus in BRIP 47735.

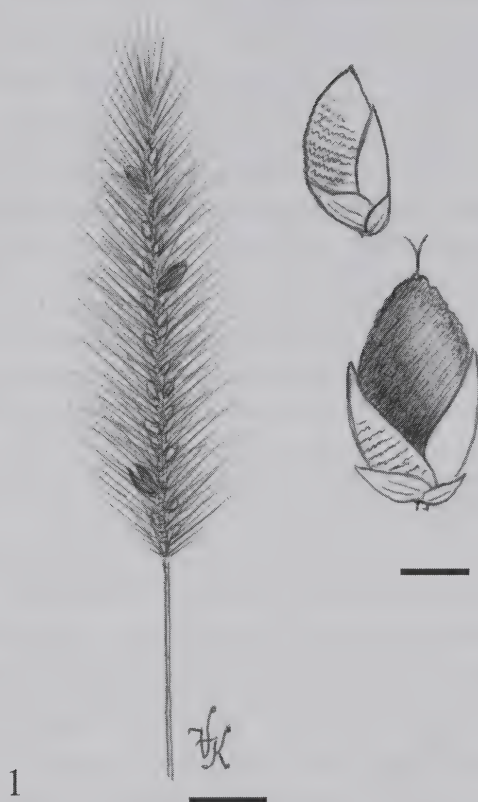


Fig. 1. Sori of *Tilletia setariae-parviflorae* in some ovaries of *Setaria parviflora* (type). Habit, and enlarged a sorus and a healthy spikelet.

Bars = 1 cm for habit, and 1 mm for detail drawings.

Sori in ovarii nonnullis inflorescentiae eiusdem, ovoideae vel ellipsoidales, $1,5-2,5 \times 2-4$ mm, inter involucris floralibus distantibus conspicuis, peridio crasso, nigrobrunneo cooperti, quo in maturitate rupto massam nigram, pulveream sporarum et cellularum steriliium ostendentes. Sporae globosae, subglobosae usque ellipsoidales, raro parum irregulares, $21-28 \times 24-32$ μm , atrobadae usque opacae, verrucis dense distributis, $2-4$ μm altis, cylindricis, apice rotundis, in visu superficiali sicut maculae atrae, irregulariter polyangulares apparentibus, $6-8(-9)$ in diametro sporae, in visu opticali mediano $24-34$ in circumferentia aequatoriali. Vagina hyalina absens. Cellulae steriles forma et magnitudine variae, plerumque collapsae, subglobosae, ellipsoidales vel irregulares, $7-30 \times 13,5-36$ μm , pallide vel mediocriter flavidobrunneae; pariete $1-2$ μm crasso, conspicue levi vel plerumque disperse, leniter vel grosse verrucoso.

Sori (Fig. 1) in some ovaries of an inflorescence, ovoid or ellipsoidal, $1,5-2,5 \times 2-4$ mm, showing between the spreading floral envelopes, covered by a thick,

blackish-brown peridium which ruptures at maturity disclosing the black, powdery mass of spores and sterile cells. *Spores* (Figs. 4, 5) globose, subglobose to ellipsoidal, rarely slightly irregular, $21\text{--}28 \times 24\text{--}32\text{ }\mu\text{m}$, dark chocolate-brown to opaque, provided with densely situated, $2\text{--}4\text{ }\mu\text{m}$ high cylindrical warts with rounded tip, in surface view appearing as dark, irregularly polyangular spots, 6-8(-9) per spore diam., in optical median view $24\text{--}34$ on the equatorial circumference. Hyaline sheath absent. *Sterile cells* (Figs. 4, 5) of varying shape and size, usually collapsed, subglobose, ellipsoidal or irregular, $7\text{--}30 \times 13.5\text{--}36\text{ }\mu\text{m}$, pale to medium dark yellowish-brown; wall $1\text{--}2\text{ }\mu\text{m}$ thick, apparently smooth or usually sparsely, finely or coarsely verrucose.

On *Setaria parviflora* (Poir.) Kerguelen; S.E. Asia (Thailand). Known only from the type locality.

Tilletia setariae-parviflorae differs from the twelve *Tilletia* species that occur on the closely related *Panicum* (comp. the key in Vánky, 2005:248).

19 *Tilletia setariae-pumilae* Vánky & N.D. Sharma, sp. nov., see ADDENDA (this volume p. 64)

20. *Ustilago crameri* Körn., Verh. Naturhist. Vereins Preuss. Rheinl. Westphalens 29:192, 1872; in Fuckel, Jahrb. Nassauischen Vereins Naturk. 27-28:11, 1873.

Holotype and isotypes, supposedly from year 1872, were lost in Berlin (B). There also is not any collection from year 1872 in the original collection of Körnicke, deposited in B since 1983. Topotype on *Setaria italica*, Germany, (= neotype; designated here) Poppelsdorf near Bonn., IX.1873, cultivated by F. Körnicke, of material originating from Switzerland, Kt. Zürich, near Zürich, Strickhof, IX.1871, C. Cramer, HUV 7297! Isoneotypes in Fuckel, Fgi. rhenani exs. no. 2511, HUV 9285!, in Rbh., Fgi. eur. no. 1900, HUV 3561!, in Thümen, Herb. myc. oecon. no. 108, HUV 9284!

Sori in all spikelets of an inflorescence destroying the ovaries and the basal part of the inner floral envelopes which become bullate, while the upper parts of the envelopes and the two glumes are normally developed, at first covered by a green, yellow or silvery peridium of host origin which ruptures irregularly disclosing the dark brown, powdery mass of spores. *Spores* extremely variable in shape, subglobose to elongate, slightly bent, irregular, subpolyhedral, pyriform, lemon- or drop-shaped, sometimes with an acute tip, $(6\text{--})7\text{--}9.5 \times 8\text{--}12\text{--}(15)\text{ }\mu\text{m}$, medium dark reddish-brown; wall even, c. $0.5\text{ }\mu\text{m}$ thick, smooth; in SEM smooth or with sparsely situated, low warts.

On *Setaria decipiens* C. Schimper (*Setaria ambigua* Guss.), *S. faberi* Herrman, *S. italica* (L.) P. Beauv., *S. verticillata* (L.) P. Beauv., *S. viridis* (L.) P. Beauv.; Europe, Africa, Asia, Australia, N. America. Cosmopolitan.

21. *Ustilago striiformis* (Westend.) Niessl, Hedwigia 15:1, 1876.

Uredo striiformis Westend., Bull. Acad. Roy. Sci. Belgique 18:406, 1851. — Lectotype on *Holcus lanatus* L., (design. by Zundel, 1953:205) Belgium, «environs de Courtrai», coll. G.D. Westendorp; isoelectotypes in Herb. crypt. Belg. no. 677, HUV 9453.

Ustilago taenia Cif., Fl. Ital. Crypt., Pars I. Fungi, Fasc. 17:346, 1938. — Type on *Setaria italica* (L.) P. Beauv., Italy, Vercelli, coll. V. de Cesati (n.v.).

For further synonyms, literature, description see Vánky, 1994:377-379 & 435-436.

On a great number of grass genera such as *Agropyron*, *Agrostis*, *Alopecurus*, *Ammophila*, *Anthoxanthum*, *Arrhenatherum*, *Avenula*, *Beckmannia*, *Brachypodium*, *Bromus*, *Calamagrostis*, *Cynosurus*, *Dactylis*, *Deschampsia*, *Deyeuxia*, *Elymus*, *Festuca*, *Helictotrichon*, *Hierochloe*, *Holcus*, *Hordeum*, *Hystrix*, *Kengia*, *Koeleria*, *Lolium*, *Melica*, *Milium*, *Pennisetum*, *Phalaris*, *Phleum*, *Poa*, *Polypogon*, *Puccinellia*, *Sesleria*, *Setaria*, *Sitanion*, *Trisetum*; cosmopolitan.

22. *Ustilago trichogena* Vánky, Mycotaxon 95:54, 2006.

Type on *Setaria setosa* var. *leianthina*, Bolivia, Dept. Tarija, Tarija, 6.II.1902, R.E. Fries 271, S; isotype HUV 5214!

For its description and illustration see Vánky, 2006b:54.

On *Setaria setosa* var. *leianthina* Hack.; S. America (Bolivia). Known only from the type collection.

Invalid names, doubtful or excluded species, or not on *Setaria*

Ustilago catherinae Zambett., Bull. Soc. Mycol. France 95:408, 1980('1979'). Invalid name, no type indicated (ICBN (Vienna) 37.1).

On *Setaria sulcata* (Bertol.) Raddi, Congo, Mukule-Mokoto, 19.XII.1914, Mission Bequet no.6326, BR 360, and on *S. chevalieri* Stapf, Congo, Mission Vanderyst, Flore du Victoriat apostrophe du Kwango, BR 363.

Sori in the "ovaries", 2-4 × 10-15 mm, protruding between the glumes, first covered by a brown peridium which later ruptures disclosing the powdery mass of spores. *Spores* single, globose, 6-8 µm in diam., pale brown; wall c. 1 µm thick, sparsely but well-visible punctate.

Ustilago darjeelingensis Bag & D.K. Agarwal, Indian Phytopathol. 54:223, 2001.

Type on *Setaria* sp., India, W.B., Darjeeling, IV.1999, M.K. Bag, HCIO 43169 (not deposited).

According to the original description: *Sori* in the ovaries, covered by glumes, composed of black, dusty mass of spores. *Spores* irregularly globose, polygonal to elongate, amber brown in colour, 8.5-9.3 × 10.2-13.6 µm in size. Epispore thick with rough edge. SEM studies showed verrucose spore wall ornamentation.

On *Setaria* sp.; S. Asia (India). Known only from the type collection.

The short and incomplete description of *U. darjeelingensis* does not permit its comparison with other similar species, and does not permit its inclusion in the key. Type specimen appears never to have been deposited in HCIO (D.K. Agarwal, in litt.), nor in any other herbarium.

Ustilago panici-latifolii* is an *Ustilaginoidea

Ustilago panici-latifolii Henn., Hedwigia 35:216, 1896. — Type on *Panicum latifolium* L., Brazil, St. Catharina, near Tubarão, III.1890, E. Ule 1331; isotypes BPI 165081!, 165082! This is an *Ustilaginoidea* sp. (anamorphic ascomycete), as noted also by M. Piepenbring in the BPI specimens. (excluded here).

Ustilago pertusa* is an *Ustilaginoidea

Ustilago pertusa Tracy & Earle, Bull. Torrey Bot. Club 22:175, 1895. — Type on *Setaria macrochaeta* (= misprint for *S. macrostachya* H. B. & K.; comp. McAlpine, 1910:159), Australia, Queensland, 1890, F.M. Bailey, VPRI 3519a, BPI 165438!

Both the VPRI and BPI specimens are lacking sori. However, there are a few spores on the envelopes which could be studied and revealed that it is an *Ustilaginoidea*, corresponding with the original description of this species. (excluded here).

***Ustilago setariae* = ?**

Ustilago setariae Rabenh. ex A.A. Fisch. Waldheim, Aperçu Syst. Ustil.:24, 1877. — Type on *Setaria* sp., no further details indicated. Description very poor: *Sori* in the panicle, destroying it, black. *Spores* globose or ellipsoidal, 10-12 µm, olivaceous-brown, epispore with very short spines.

The very short and incomplete original description, and lack of type specimen, do not allow its identification.

Ustilago setariae-aureae* is an *Ustilaginoidea

Ustilago setariae-aureae Henn., in Wildeman, Ann. Mus. Congo, Sér. 5, Bot. 2:86, 1907. — Type on *Setaria aurea* A. Br. (= *S. sphacelata* var. *aurea* (A. Br.) W.D. Clayton), Congo, Leopoldville Prov., Dembo, VI.1906, H. Vanderyst B28, BR; isotypes in BPI 166389!, 166390!, 194472!, HUV 17147! (excluded by Vánky, 1999:160).

Ustilago urbanii* is *Sclerospora graminicola

Ustilago urbanii Magnus, Verh. Bot. Vereins Prov. Brandenburg 20:52, 1878 (as '*urbani*'). — Type on *Setaria viridis* (L.) P. Beauv., Germany, near Berlin, Lichterfelde, 1875, I. Urban, BPI 168728.

It is *Protomyces graminicola* Sacc. = *Sclerospora graminicola* (Sacc.) J. Schröt.

Ustilago viridis* is *Ustilaginoidea setariae

Ustilago viridis Ellis & Everh., J. Mycol. 3:56, 1887. — Type on *Setaria* sp., USA, Louisiana, St. Bernard Parish, Shell Beach, 8.X.1885, A.B. Langlois 56, BPI 183713; isotypes BPI 169494, 183712.

It is *Ustilaginoidea setariae* Bref. (excluded by Clinton, 1902:130).

Key to the smut fungi of *Setaria*

1. Sori on leaves forming striae *Ustilago striiformis*
- Sori elsewhere, not so 2
2. Sori in distal part of sterile shoots, up to 7 cm or longer? *Sporisorium kenyanum*
- Sori in the ovaries or spikelets, much shorter 3
3. Conidia present between the spores; sori thick, sack-like, opened 4
- Conidia absent between the spores; sori not so 6
4. Spore mass grey to pale chestnut-brown; immature spores and conidia between the spores abundant 5
- Spore mass reddish-brown; immature spores and conidia relatively few; spores coarsely conical-echinulate *Conidiosporomyces verrucosus*
5. Spores 13-17 µm long, predominantly verrucose or verrucose-echinulate, warts 1-2 µm high, often flattened *Conidiosporomyces ayresii*
- Spores (14.5-)16-20(-23) µm long, predominantly filamentously verrucose, warts 1.5-3(-5) µm high *Conidiosporomyces echinospermus*
6. Spores over 13 µm long 7
- Spores less than 13 µm long 14
7. Sori pubescent 8
- Sori smooth to rough, not pubescent 9
8. Spores reticulate, 18-23 µm long *Tilletia setariicola*
- Spores finely, densely verrucose, 13-18 µm long *Tilletia zundelii*
9. Spores 13-19(-22) µm long; warts c. 1 µm high, blunt. . . *Tilletia thirumalacharii*
- Spores larger; warts higher 10
10. Spores 16-24 µm long; warts delicate, 2-4 µm high, subacute *Tilletia setariae-palmifoliae*
- Spores larger. 11
11. Spores 18.5-25(-26) µm long; warts 1.5-2.5 µm high, cylindrical or subpyramidal, with a flattened or rounded tip, 6-11 per spore diam. . . *Tilletia setariae-pumilae*
- Spores larger. 12
12. Spores 22.5-28 µm long; warts delicate, acute, 1.5-2.5 µm high, 11-17 per spore diam. *Tilletia setariae-viridis*
- Spores larger. 13
13. Spores 20-30(-33) µm long; warts subconical or cylindrical, 1.5-3 µm high, 8-13 per spore diam.; hyaline sheath present. *Tilletia setariae*
- Spores 24-32 µm long; warts cylindrical, 2-4 µm high, 6-8(-9) per spore diam.; hyaline sheath absent *Tilletia setariae-parviflorae*
- 14(6) Columella several; spores dimorphic *Sporisorium setariae*
- Columella one or lacking; spores not dimorphic 15
15. Sori bullate at their basal part; spores smooth *Ustilago crameri*
- Sori not bullate; spores ornamented. 16
16. Sori hispid *Ustilago trichogena*
- Sori not hispid 17

17. Sori in some ovaries or spikelets of an inflorescence 18
- Sori in all ovaries or spikelets of an inflorescence 20
18. Spores 6-9 μm long, sparsely echinulate *Sporisorium setariae-mombassanae*
- Spores larger. 19
19. Spores 7-10.5(-11) μm long, finely, densely punctate-verruculose
- *Macalpinomyces sharmae*
- Spores 9-12 μm long, densely echinulate. *Macalpinomyces tanakae*
20. Spores firmly united in balls *Sporisorium setariicola*
- Spores single or in loose balls 21
21. Columella stout, irregular, often with short apical branches
- *Sporisorium magnusianum*
- Columella short, ovoid. *Macalpinomyces neglectus*

The smut fungi of *Eragrostis* (Poaceae)

Eragrostis Wolf is a large and variable genus with about 350 species in the tropics and subtropics of the world. It belongs to the subfam. *Chloridoideae*, tribe *Eragrostideae*, subtribe *Eleusininae* (Clayton & Renvoize 1986:215, 218). On *Eragrostis* at least 18 smut fungi have been described. Of these *Sorosporium turneri* McAlpine (The smuts of Australia:185, 1910) is not on *Eragrostis nigra* var. *trachycarpa* Benth. but on *Panicum* cf. *effusum* R. Br. (teste L.A.S. Johnson, in herb.). In contrary, the host plant of the type of *Ustilago pimprina* is not *Arundinella* sp. but *Eragrostis* sp. Several of the published names proved to be synonyms. *Tilletia bangalorensis* is *T. transvaalensis*, *T. durangensis* Durán is *T. baldratii*, *Ustilago strangulans* Issatsch. is *Sporisorium montaniense*. Furthermore, *U. kusanoana* Henn., *U. orientalis* W.Y. Yen, *U. eragrostidis-japonicana* Zundel, *Sphacelotheca cheoana* Zundel, and *Sporisorium eragrostidis-viscosae* are synonyms of *Macalpinomyces spermophorus*, and *U. spermophoroides*, and *U. pimprina* are synonyms of *U. egenula* (see below).

On *Eragrostis* nine smut fungi could be recognised, including two new species.

1. *Macalpinomyces spermophorus* (Berk. & M.A. Curtis ex De Toni) Vánky, Fungal Diversity 14:210, 2003.

Ustilago spermophora Berk. & M.A. Curtis ex De Toni, in Saccardo, Sylloge fungorum, etc., 7:466A, 1888. — Type on *Eragrostis poaeoides* var. *megastachya* (= *E. cilianensis*), USA.

Sporisorium eragrostidis-viscosae A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:782, 2004. — Type on *Eragrostis viscosa*, India, Maharashtra State, Kolhapur, 12.XII.1997, M.S. Patil, HCIO 42846; isotypes Kolhapur W.I.F. 1535, HUV 21263. (syn. nov.). Presence of spore balls in the type collection is result of insect work.

For further nomenclatural and taxonomic synonyms, types, description and illustrations see Vánky (1994:376, 435; 2003b:210-212).

On *Bouteloua aristidoides* (Kunth) Griseb., *B. chondrosioides* (Kunth) Benth. ex S. Watson, *B. filiformis* (Fourn.) Griff., *B. gracilis* (Kunth) Lag. ex Steud. (*B. oligostachya* Torr.), *B. hirsuta* Lag., *B. repens* (Kunth) Scribn., *B. rothrockii* Vasey, *B. simplex* Lag. (*Chondrosium simplex* (Lag.) Kunth), *Cathestecum erectum* Vasey & Hack., *Ca. prostratum* Presl, *Eragrostis cilianensis* (All.) Lutati (*E. poaeoides* var. *megastachya* (Link) A. Gray; *E. major* Host; *E. megastachya* (Koeler) Link), *E. ferruginea* (Thunb.) P. Beauv., *E. japonica* (Thunb.) Trin., *E. mexicana* (Hornem.) Link, *E. minor* Host (*E. poaeoides* P. Beauv.), *E. pilosa* (L.) P. Beauv., *E. tenuifolia* Hochst., *E. tremula* Hochst. ex Steud. (*E. rachitricha* Hochst. ex Miq.), *E. secundiflora* Presl, *E. simplex* Scribn., *E. tenuifolia* Hochst. ex Steud., *E. tremula* Hochst. ex Steud., *E. viscosa* (Retz.) Trin., *Hilaria belangeri* var. *longifolia* (Vasey) Hitchc., *Panicum* sp., *Sporobolus australasicus* Domin; cosmopolitan.

2. *Sporisorium montaniense* (Ellis & Holw.) Vánky, Symb. Bot. Upsal. 24(2):118, 1985 (as '*montaniensis*').

Type on *Muhlenbergia glomerata*, USA.

For synonyms, types, description and illustrations see Vánky, 1994:203 & 215.

On *Eragrostis arida* Hitchc., *E. diffusa* Buckl., *E. mexicana* (Hornem.) Link, *E. minor* Host (*E. poaeoides* P. Beauv.), *E. neomexicana* Vasey, *E. pectinacea* (Michx.) Nees, *Muhlenbergia asperifolia* (Nees & Meyen ex Trin.) O. Matthei, *M. cuspidata* (Torr.) Rydb., *M. glomerata* (Willd.) Trin., *M. pulcherrima* Scribn., *M. racemosa* (Michx.) Britton, Sterns & Poggenb.; cosmopolitan.

3. *Tilletia baldratii* Montem., Boll. Stud. Inform. Reale Giardino Colon. 13:44, 1934.

Type on *Poa abyssinica* (= *Eragrostis tef*), Africa, Eritrea, comm. I. Baldrati. (Type where?)

It is not in FT or FI (C. Nepi, in litt.).

For synonyms, types and description see Vánky, 2004:113.

On *Eragrostis mexicana* (Hornem.) Link, *E. tef* (Zucc.) Trotter (*Poa abyssinica* Jacq.); N. Africa, N. America.

4. *Tilletia eragrostidis* G.P. Clinton & Ricker, in Ricker, J. Mycol. 11:111, 1905.

Type on *Eragrostis glomerata*, USA, Mississippi, Yazoo City, 8.IX.1904, S.M. Tracy, BPI 172896; isotypes BPI 172894, 172897, HUV 15350.

Sori in some ovaries of an inflorescence, showing between the spreading floral envelopes as ovoid, inconspicuous, $0.3-0.8 \times 0.8-1.4$ mm small bodies, first covered by the thin pericarp which ruptures irregularly disclosing the blackish-brown, semiagglutinated to powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid to ellipsoidal, $25-36 \times 28-40$ μm , yellowish- to dark reddish-brown, in some collections to opaque; wall $3.5-7$ μm thick, including the $2.5-5.5$ μm high, truncate warts which in surface view appear as darker, densely situated, irregularly polygonal areas, 6-10 per spore diam. *Sterile cells* globose to ellipsoidal, $14-24 \times 16-28$ μm , subhyaline to pale yellowish-brown; wall $3-4$ μm thick, smooth to finely punctate.

On *Eragrostis glomerata* (Walt.) L.H. Dewey, *E. japonica* (Thunb.) Trin., *E. tenellula* (Kunth) Steud.; C. Africa, Australia, N. America.

5. *Tilletia kenyana* Vánky, Mycotaxon 89:80, 2004.

Type on *Eragrostis caespitosa*, Kenya.

For description and illustrations see Vánky, 2004:80, 83 & 90.

On *Eragrostis caespitosa* Chiov.; Africa. Known only from the type locality.

6. *Tilletia thailandica* Vánky & R.G. Shivas, sp. nov.

MYCOBANK510357.

Typus in matrice *Eragrostis amabilis* (L.) Wight & Arn. (det. H. Scholz, B), Thailand, Loei Prov., Dan Sai Distr., 75 km E urbe Loei, 17°18'20.9" N, 101°12'09.2" E, alt. 487 m.s.m., 22.XII.2005, leg. R.G., M.D.E., A.J. & G.E. Shivas, P. Athipunyakom, S. Likhitekaraj, W. Butranu, C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 21206, isotypus in BRIP 48134.

Tilletia thailandica distincta a specie simili *T. kenyana* Vánky (Mycotaxon 89:80, 2004, *typus in matrice* *Eragrostis caespitosa*, Kenya) magnitudine, colore et ornamentatione sporarum. Sporae speciei *T. thailandica* 17,5-21,5 µm longae, flavido- usque atro-rubrobrunneae, verrucis 2-2,5 µm altis, apice depressis raro subacutis, 21-29 in circumferentia aequatoriali, vagina hyalina absens. Sporae speciei *T. kenyana* 13-19 µm longae, pallide flavae vel pallide flavobrunneae, verrucis 1,5-2,5(-3) µm altis, obtusis, subpyramidalibus, 17-21 secundum circumferentiam aequatorialem, in vagina hyalinae inclusae.

Sori (Fig. 2) in some ovaries of an inflorescence, inconspicuous, ovoid or ellipsoidal, 0.3-0.5 × 0.4-1 mm, more or less hidden by the floral envelopes, at first covered by a thin, dark greyish peridium of the pericarp which ruptures irregularly disclosing the black, semiagglutinated to powdery mass of spores and sterile cells or the sori disintegrate into small pieces. *Spores* (Figs. 6, 7) globose, subglobose to broadly ellipsoidal, 16-21 × 17.5-21.5 µm, yellowish- to dark reddish-brown; wall even, provided with 2-2.5 µm high warts with flattened, rarely subacute tip, in surface view appearing as densely situated, irregularly polyangular, dark spots, 5-7 per spore diam., separated by regularly narrow, bright lines, in median view 21-29 warts on the equatorial circumference, hyaline sheath absent. *Sterile cells* (Figs. 6, 7) varying in size, colour and ornamentation, globose, subglobose to ellipsoidal, 8-23 × 9.5-25 µm, subhyaline to pale yellowish-brown; wall even, 0.5-1.5 µm thick, smooth, finely, regularly, sparsely verrucose or with irregularly grouped, large, cylindrical warts.

On *Eragrostis amabilis* (L.) Wight & Arn.; S.E. Asia (Thailand). Known only from the type locality.

Tilletia thailandica differs from the similar *T. kenyana*, in which the spores are 13-19 µm long, pale yellow or pale yellowish-brown, and are provided with 1.5-2.5(-3) µm high, blunt, subpyramidal warts, 17-21 on the equatorial circumference, embedded in a hyaline sheath.



Fig. 2. Sori of *Tilletia thailandica* in some ovaries of *Eragrostis amabilis* (type). Habit, and enlarged a spikelet with a sori.
Bars = 1 cm for habit, and 1 mm for detail drawing.

7. *Tilletia transvaalensis* Zundel, Mycologia 23:299, 1931.

Type on *Eragrostis aspera*, South Africa, Transvaal, Zebediela Distr., Mucklenburg, 6.VI.1913 (on the label 6.VI.1930), G.W. Wearing, PREM 25463; isotypes BPI 173907, BPI 195171, HCIO 10144, HUV 15416.

Tilletia bangalorensis Pavgi & Thirum., in Thirumalachar & Pavgi, Mycopathol. Mycol. Appl. 7:285, 1956. — Type on *Eragrostis tenuifolia*, India, Bangalore, 15.X.1952, H.C. Govindu, HCIO 20998; isotypes IMI, BPI, HUV 16002. (syn. by Durán & Fischer, 1961:113, confirmed).

Sori in ovaries, infecting some or all of a spikelet, ovoid or ellipsoidal, 0.5-1 × 1-1.5 mm, more or less hidden by the floral envelopes and covered by a greyish-brown membrane of the pericarp, which ruptures irregularly, disclosing the dark brown, semiagglutinated to powdery mass of spores and sterile cells. *Spores* globose or subglobose, rarely broadly ellipsoidal, 17-21.5 × 18-25 µm, pale yellowish-brown to yellowish-brown, provided with densely situated, large, pyramidal, pointed spines, 2.5-4 µm wide, polyangular at the base, 2.5-4 µm high, which project to the margin of the gelatinous sheath, in surface view appearing as darker, polyangular areas, 3-5 per spore diam. *Sterile cells* numerous, globose, subglobose or ellipsoidal, 10-18 × 12-22 µm, subhyaline to yellowish-brown tinted; wall 1.5-6 µm thick, smooth, content granular.

On *Eragrostis aspera* (Jacq.) Nees, *E. plumosa* Link, *E. tenuifolia* Hochst. ex Steud.; S. Africa, S. Asia.

8. *Ustilago egenula* Syd., P. Syd. & Butler, Ann. Mycol. 10:251, 1912.

Type on *Eragrostis nutans*, India, Bihar, near Pusa, 8.XII.1910, E.J. Butler 1429, HCIO 1429; isotypes HUV 15659, 17335, and in Vánky, Ust. exs. no. 872.

Ustilago spermophoroides Y. Ling & T.L. Chen, Res. Bull. Inst. Zool. Bot. Fukien Acad. 1:5, 1945. — Type on *Eragrostis japonica*, China, Fukien, Shawsien, 10.X.1942, T.L. Chen 301 (syn. nov.). Ling (1953b:324) considered it a synonym of *U. spermophora*. According to the original description, *U. spermophoroides* differs from *U. spermophora* by larger and darker spores.

Ustilago pimprina Thirum. & Pavgi, Sydowia 22:251, 1968(1969). — Type on "*Arundinella* sp." (= misnamed *Eragrostis* sp., teste K. Vánky, based on the illustrations), India, Puna, at Pimpri, X.1955, M.J. Thirumalachar, (type where?). (Syn. by Vánky, 2004:93).

Sporisorium eragrostidis A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:782, 2004. — Type on *Eragrostis japonica*, India, Maharashtra State, Kolhapur, Shivaji University Campus, 7.I.1998, M.S. Patil, HCIO 42867; isotypes Kolhapur W.I.F. 1534, HUV 21262. (syn. nov.).

Sori in some ovaries of an inflorescence, inconspicuous, subglobose, ellipsoidal, ovoid or usually lemon-shaped, 0.2-0.7 × 0.3-1 mm, partly hidden by the floral envelopes and covered by the thin pericarp which may rupture irregularly from its apex, disclosing the blackish-brown, semiagglutinated to powdery mass of spores and sterile cells, or the sori fall off the plant unopened. *Spores* varying in shape, size and appearance, slightly compressed, in side view more or less elliptic, 8-12 µm wide, in face view circular, broadly elliptic or subpolyangularly

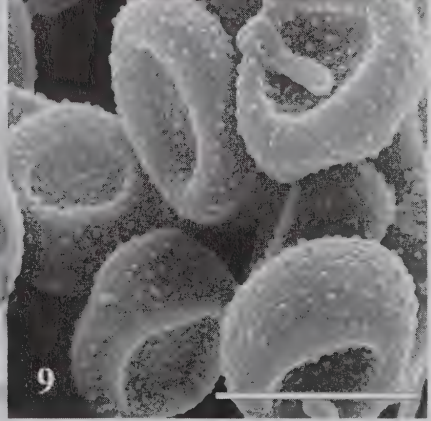
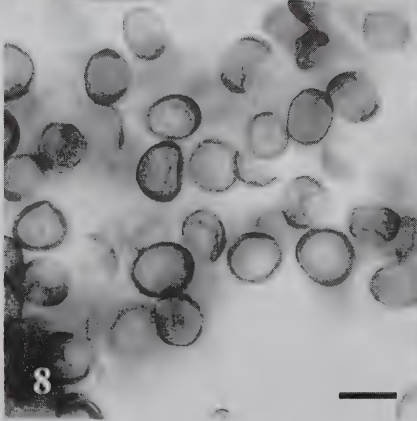
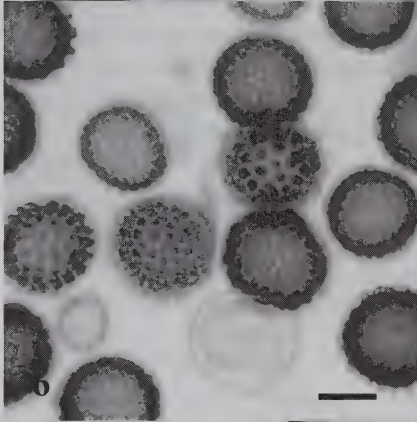
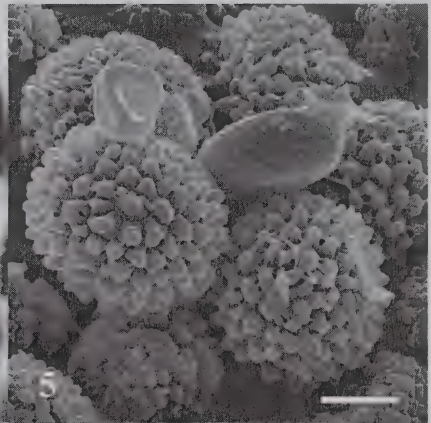
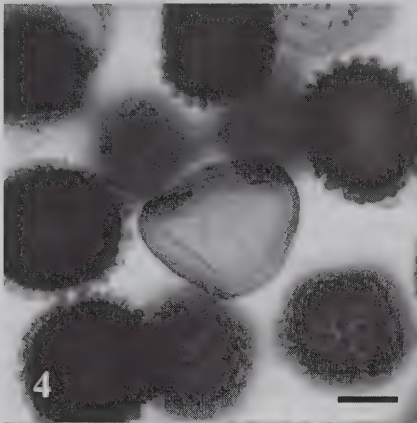


Fig. 3. Sori of *Ustilago planetella* in some ovaries of *Eragrostis japonica* (type). Habit, and enlarged a few spikelets with sori. Bars = 1 cm for habit, and 2 mm for detail drawing.

Figs. 4, 5. Spores and sterile cells of *Tilletia setariae-parviflorae* on *Setaria parviflora* in LM and in SEM (type).

Figs. 6, 7. Spores and sterile cells of *Tilletia thailandica* on *Eragrostis amabilis* in LM and in SEM (type).

Figs. 8, 9. Spores of *Ustilago planetella* on *Eragrostis japonica* in LM and in SEM (type). Bars = 10 μ m.



irregular, $9.5\text{--}13 \times 10\text{--}14\text{--}(16) \mu\text{m}$, medium dark yellowish-brown, in some of the spores more or less expressed, one or several, regularly situated, bright, circular spots are present, $0.5\text{--}0.8 \mu\text{m}$ in diam., up to 4-8 per spore diam.; spore wall uneven, $0.5\text{--}1 \mu\text{m}$ thick, thinner on the flattened sides, surface finely, densely, uniformly verrucose-echinulate, spore profile nearly smooth to finely serrulate. Sterile cells in irregular groups or solitary, single cells globose, subglobose to broadly ellipsoidal, rarely with a flattened side, $5.5\text{--}13.5 \times 5.5\text{--}14.5 \mu\text{m}$, hyaline, content homogenous; wall even, c. $0.5 \mu\text{m}$ thick, smooth.

On *Eragrostis diplachnoides* Steud., *E. japonica* (Thunb.) Trin., *E. nutans* (Retz.) Nees ex Steud., *E. tenella* (L.) P. Beauv. ex Roem. & Schult. (*E. plumosa* (Retz.) Link); S., E. & S.E. Asia (China, India, Pakistan, Thailand).

Presence of sterile cells between the spores is typical for the genera *Macalpinomyces* or *Sporisorium* rather than for *Ustilago*. Discordant results obtained by morphological and molecular methods for members of these genera indicate that it is best not to recombine this species at the moment.

Ustilago egenula differs from the polyphageous *Macalpinomyces spermophorus*, in which the top of the sori usually have a hard, yellowish-brown, acute body, the remnant of the caryopsis, and the spores are smaller ($6.5\text{--}9\text{--}(10) \times 8\text{--}11\text{--}(13) \mu\text{m}$), lighter brown in colour and without bright spots.

9. *Ustilago planetella* Vánky & R.G. Shivas, sp. nov.

MYCOBANK510364.

Typus in matrice Eragrostis japonica (Thunb.) Trin. (det. H. Scholz, B), Thailand, Uttaradit Prov., Tron Distr., cca. 12 km SE urbe Uttaradit, $17^{\circ}33'18.4''$ N, $100^{\circ}10'17.8''$ E, alt. 116 m.s.m., 23.XII.2005, leg. R.G., M.D.E., A.J. & G.E. Shivas, P. Athipunyakom, S. Likhitekaraj, W. Butranu, C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 21205, isotypi in BPI 872195, in Herb. M. Piątek (HeMP-114).

Ustilago planetella distincta a specie Ustilago spermophora Berk. & M.A. Curtis ex De Toni, in Saccardo, *Sylloge fungorum*, etc., 7:466, 1888 [= *Macalpinomyces spermophorus*], *penuria residui caryopsidis in apice sori et praecipue ligamento typico atriore aequatoriali sporarum maturarum areisque 2 pallidioribus parietis tenuibus polaribus, et absentia cellularum sterilium. Apex sori speciei Macalpinomyces spermophorus corpore duro flavidobrunneo, acuto et sporae uniformiter pigmentatae, sine areis polaribus pallidioribus, cellulae steriles inter sporas praesens.*

Sori (Fig. 3) in some spikelets of an inflorescence destroying the innermost floral organs, inconspicuous, globose, ovoid or broadly ellipsoidal, $0.2\text{--}0.5 \times 0.2\text{--}0.6$ mm, more or less hidden by the glumes, at first covered by a thin, greyish peridium which ruptures irregularly at maturity disclosing the dark brown, powdery mass of spores. Spores (Figs. 8, 9) slightly compressed or not, in side view circular to elliptic, $7\text{--}10 \mu\text{m}$ wide, with two, thin-walled, subhyaline polar areas and a wide, darker equatorial band, in face view spores circular, subcircular or broadly elliptic, $8\text{--}10.5 \times 9\text{--}12 \mu\text{m}$, pale yellowish-brown with a round, paler, central spot, $3\text{--}5 \mu\text{m}$ in diam., corresponding to the polar area;

spore wall uneven, c. 1 μm thick at the darker, equatorial band, and c. 0.5 μm at the polar areas, surface apparently smooth to finely, sparsely to moderately densely punctate-verruculose, spore profile smooth to finely wavy at the polar areas. *Sterile cells* not seen.

On *Eragrostis japonica* (Thunb.) Trin.; S.E. Asia (Thailand). Known only from the type locality.

Etymology: The specific epithet refers to the smut genus *Planetella* Savile, with its type *P. lironis* Savile, on *Carex* spp., in which the spores also have a dark, equatorial band and two, paler polar areas. It is important to note that the immature spores are uniformly pale yellowish-brown pigmented, thin-walled. The typical darker, equatorial band is present in mature spores only.

Ustilago planetella differs from *Ustilago spermophora* [= *Macalpinomyces spermophorus*] by the lack of a caryopsis remnant on the top of the sori, by mature spores with a typical, dark equatorial band and two, paler, thin-walled polar areas, and absence of sterile cells. In *M. spermophorus* has usually a hard, yellowish-brown, acute body on the top of the sori spores that are uniformly pigmented, lacking paler polar areas, and sterile cells between the spores.

The ITS 1 and ITS 2 regions of the rDNA including the 5.8S rDNA (ITS) and the 5'-end of the nuclear large subunit ribosomal DNA (LSU) of *Ustilago planetella* were sequenced by Dr. M. Lutz. [GenBank accession numbers: EF040584 (ITS), EF040583 (LSU)]. Molecular phylogenetic analyses using the dataset of Stoll et al. (2005) revealed a position within *Ustilago* s.l. in a cluster together with *U. calamagrostidis*, *U. cynodontis*, *U. sparsa*, *U. striiformis*, and *U. xerochloae*.

Melanotaenium eragrostidis* is *Jamesdicksonia tremuli

Melanotaenium eragrostidis A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:82, 2004, type on "*Eragrostis pilosa* (L.) P. Beauv.", India, Maharashtra State, Kolhapur, Shivaji University Campus, 24.VII.1997, M.S. Patil, HClO 42799; isotypes Kolhapur W.I.F. 1513, HUV 21254. The host plant turned out to be a *Sporobolus* sp. (conf. H. Scholz, B), as it can be seen also on fig. 33, in Patil et al. (2004b:843).

Of the three *Jamesdicksonia* ("*Melanotaenium*") species on *Sporobolus*, *M. eragrostidis* fits with *J. tremuli* Vánky (Vanky 2003:209), type on *Sporobolus tremulus*, India, hence they are considered synonyms.

Sori forming lead-coloured, rounded, or ellipsoidal pustules on the leaves, 0.5–2 mm long, or longer by confluence, covered by the epidermis which later ruptures longitudinally, revealing the black, agglutinated spore mass embedded in the leaf tissue. Spores agglutinated into irregular groups, single spores extremely variable in shape and size, usually irregular, with one or several flattened sides,

often elongated, broadly subfusiform or also triangular, with one or several acute or subacute tips, 9-15 × 11-20(-28) µm, dark olivaceous-brown; wall two-layered, endospore even, thin, c. 0.5 µm, exospore uneven, 1.5-7(-8) µm thick, smooth.

On *Poaceae*: *Sporobolus diander* (Retz.) P. Beauv., *S. tremulus* Kunth, *S. wallichii* Munro; S. Asia (India, Nepal).

Key to the smut fungi of *Eragrostis*

1. Sori on the top of shoots, up to 2-3 cm long *Sporisorium montaniense*
– Sori in spikelets or ovaries, much smaller 2
2. Sori in spikelets; spores with a darker equatorial band *Ustilago planetella*
– Sori in ovaries; spores without a darker equatorial band 3
3. Spores over 17.5 µm long 4
– Spores less than 19 µm long 7
4. Spores reticulate *Tilletia baldratii*
– Spores with pointed, subacute or truncate pyramidal or cylindrical warts 5
5. Spores 28-40 µm long, warts 2.5-5.5 µm high *Tilletia eragrostidis*
– Spores less than 25 µm long, warts lower 6
6. Warts 2-2.5 µm high, flattened, 5-7 per spore diam. *Tilletia thailandica*
– Warts 2.5-4 µm high, pointed, pyramidal, 3-5 per spore diam. *T. transvaalensis*
- 7(3) Spores with 1.5-2.5(-3) µm high, subpyramidal warts *Tilletia kenya*
– Spores punctate, verruculose or finely echinulate 8
8. Sori often with an acute remnant of the caryopsis; spores 8-11(-13) µm long; wall even, c. 0.5 µm thick, without brighter spots *Macalpinomyces spermophorus*
– Sori without an acute remnant of the caryopsis; spores 10-14(-16) µm long; wall uneven, 0.5-1 µm thick, often with brighter spots *Ustilago egenula*

The smut fungi of *Eleusine* (*Poaceae*)

Eleusine Gaertn., in the subfam. *Chloridoideae*, tribe *Eragrostideae*, subtribe *Eleusininae*, has nine species, mostly in E and NE tropical Africa. *E. coracana* is widely grown as a cereal in Africa, India and China. *Eleusine* is linked with *Dactyloctenium* (Clayton & Renvoize, 1986:222). Several smut fungi have been described on *Eleusine*. Some of them are actually on *Dactyloctenium*, such as *Tilletia eleusines* Syd., type on *Eleusine aegyptia* (L.) Desf. (= *Dactyloctenium aegyptium* (L.) P. Beauv.), or *Ustilago idonea*. *Ustilago pavginensis* and *U. coelachyri* were found to be identical with *U. eleusines* Kulk.

Ustilago eleusines Kulk., Ann. Appl. Biol. (India) 9:184, 1922 (as '*eleusinis*').

Melanopsichium eleusines (Kulk.) Mundk. & Thirum., Mycol. Pap. 16:1, 1946 (as '*eleusinis*').

— Type on *Eleusine coracana*, India, Bombay Presidency (= Maharashtra State), Malkapur, X.1918, G.S. Kulkarni, HClO 100093; isotype IMI. Topotypes: 26.X.1920, HClO 22662, HUV 17336!

Ustilago pavginensis Gandhe, Smuts of Maharashtra. Doctoral Thesis, University of Poona:34, 1978 (invalidly published, typewritten, ICBN (Vienna) 29.1, 30.5). — On *Eleusine coracana*, India, Maharashtra State, Kolhapur, 15.X.1976, V.A. Kambale, HCIO 33480; isotypes Herb. Gandhe, and HUV 17545! (syn. nov.).

Ustilago coelachyri A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:842, 2004 (as '*coelachyrae*'). — Type on *Coelachyrum lagopoides* (*Eleusine brevifolia*), India, Tamil Nadu, Madurai, 19.XI.1987, S.R. Yadav, HCIO 42831; isotypes Kolhapur W.I.F. 1571, HUV 18315 & 21270! (syn. nov.).

Sori in some spikelets of an inflorescence, destroying the ovaries and also the inner floral organs, often in groups and may be confluent, globose, ellipsoidal or lobed, 1-2(-3) mm in length, first green later dark brown, covered by a thin peridium and partly hidden by the glumes. Spore mass blackish-brown, semiagglutinated to powdery. *Spores* globose, ovoid or ellipsoidal, (7-)8-10.5 × 9-12(-13) µm, yellowish-brown; wall even, 0.5-0.8 µm thick, finely, moderately densely echinulate, spore profile nearly smooth to very finely serrulate. *Spore germination* (Kulkarni, 1922:184-185) results in septate basidia with ellipsoidal or fusiform basidiospores produced laterally and terminally.

On *Coelachyrum lagopoides* (Burm. f.) Senaratna (*Eleusine brevifolia* (Willd.) R. Br. ex Hook. f.), *Eleusine coracana* (L.) Gaertn., *E. indica* (L.) Gaertn.; Africa, S. & E. Asia.

Another smut fungus described on "*Eleusine*" is *Ustilago eleusines* Syd., Ann. Mycol. 27:421, 1929. — Type on "*Eleusine indica* Gaertn." (= misnamed *Digitaria* sp., teste K. Vánky), China, Kiangsu Prov., Nanking, X.1928, F.L. Tai 2249. Holotype in B (lost); isotype (= lectotype, designated here) BPI 160347!

The difference between the names "*eleusines*" and "*eleusinis*" is small. The second name is a result of a grammatical error which must be corrected to *eleusines* [ICBN (Vienna) Article 32.7] resulting in homonymy. Mundkur (1940:333) recognised the homonymy and, without seeing the type, renamed Sydow's species as *Ustilago sydowiana* Mundk. At the same time, Mundkur (1940:333) considered *U. eleusines* Syd. to be identical with the fungus collected by S. Ahmad in Punjab on *Dactyloctenium indicum*, which is erroneous. The original description of *U. eleusines* by Sydow (1929:421) is clearly different from the smut of *D. indicum*, described by Sydow as *Ustilago idonea* Syd. (Sydow & Ahmad, 1939:432), type on *Eleusine aristata* Ehrenb. (= *Dactyloctenium indicum* Boiss.), India, Punjab, Sheikhpura, coll. S. Ahmad 71.

The type of *U. eleusines* Syd. was lost in B (Berlin, H. Scholz, pers. comm.). Fortunately, there is an isotype ("cotype") of it preserved in BPI 160347, which is proposed as lectotype. Some smutted inflorescences bear remnants of spikelets on their distal parts. Their study surprisingly revealed that the host plant is not *Eleusine indica* but a species of *Digitaria*, and the smut proved to be identical with *Ustilago syntherismae*. Consequently, *Ustilago sydowiana* Mundk. (*U. eleusines* Syd., non Kulk.) is a synonym of *U. syntherismae* (Schwein.) Peck on *Digitaria* sp. (syn. nov.).

The smut fungi of *Limnanthemum* (Menyanthaceae)

Winter (1885:102) described *Doassansia decipiens* on the leaves of *Limnanthemum lacunosum*, from USA, with the remarks: "This is a very interesting but doubtful species". Clinton (1902:154) placed it under *Burrillia*, because "The spore-balls of this species have no definite cortical layer". Study of the type specimen revealed a thin cortical layer, and a ball structure typical for *Doassansia*.

Doassansia decipiens G. Winter, J. Mycol. 1:102, 1885.

Burrillia decipiens (G. Winter) G.P. Clinton, J. Mycol. 8:154, 1902. — Type on *Limnanthemum lacunosum*, USA, New Jersey, Morri Co., Green Pond, 7.VIII.1883, E.A. Rau, BPI 178283!

Sori forming circular to slightly irregular, yellowish-brown spots on the adaxial side of the leaves, 1.5-2 mm in diam., with numerous spore balls embedded in the host tissue appearing as closely clustered, minute, dark brown elevations. *Spore balls* globose, subglobose, ellipsoidal to irregular, 80-160 µm long or longer by confluence, pale brown, composed of a central mass of tightly packed spores surrounded by a thin cortical layer of sterile cells. *Spores* subglobose, ovoid, ellipsoidal to irregular by slightly flattened sides, 7-12 × 8-13.5 µm, pale yellowish-brown; wall even, c. 0.5 µm thick, smooth. *Cortex* continuous or sometimes interrupted, composed of one or several layers of tangentially flattened, irregular, empty cells, 1-5 × 3-10.5 µm, slightly darker than the spores; wall c. 0.5 µm thick, smooth.

On *Limnanthemum lacunosum* (Vent.) Griseb. (*Nymphoides lacunosa* (Vent.) Kuntze), *L. trachyspermum* A. Gray, *Nymphoides cordata* (Ell.) Fernald; N. America (Canada, USA).

Ciferri (1931:22) described *Burrillia limnanthemii* on the leaves of *Limnanthemum humboldtianum*, from the Dominican Republic. The type seems to be lost. However, based on the description (reproduced below), it is a *Doassansiopsis* as:

Doassansiopsis limnanthemii (Cif.) Vánky, comb. nov.

MYCOBANK 510380.

Basionym: *Burrillia limnanthemii* Cif., Ark. Bot. 23 A:22, 1931. — Type on *Limnanthemum humboldtianum*, Dominican Republic, Prov. Santo Domingo, Llano Costero, between Guerra and Cuenca, VIII.1929, R. Ciferri 2531 (type where?).

Sori on the leaves forming irregular, scattered, yellowish spots, 2-3 mm in diam., with an indefinite discoloured margin. *Spore balls* embedded in the host tissue, formed of a central mass of parenchymatous fungal cells surrounded by a layer of radially elongated spores. *Spores* subpolyhedral, elongated, 4-6 × 15-19 µm, light yellowish; wall rather thick (c. 2 µm), smooth. *Sterile cells* subpolyhedral, 37-45 × 44-52 µm, light yellowish-brown.

On *Limnanthemum humboldtianum* (Kunth) Grieseb., ?*Nymphoides cordata* (Ell.) Fernald; N. America (Canada, USA), Antilles (Dominican Republic).

Key to the smut fungi of *Limnanthemum*

- Spores radially elongated, 15-19 µm long, surrounding a central mass of sterile, parenchymatous cells *Doassansiopsis limnanthemii*
- Spores rounded, 8-13.5 µm long, filling the balls, surrounded by a thin cortex of flattened sterile cells *Doassansia decipiens*

The smut fungi of *Acanthaceae*

On the nearly 3000, mostly tropical species of *Acanthaceae* only four smut fungi have been described, all belonging to the order *Doassansiales* R. Bauer & Oberw., and all are from India, on aquatic or paludal plants. These are: *Burillia kamatii*, *Doassansia hemigraphiae*, *D. hygrophilae*, and *D. khandalensis*. Of these, *Burillia kamatii* is a *Doassansia*, whereas *Doassansia hygrophilae* and *D. khandalensis* belong to the genus *Heterodoassansia*. (For the characters of *Burillia*, *Doassansia* and *Heterodoassansia* see Vánky, 2002). The recognised four species are:

1. *Doassansia kamatii* (S.B. Thakur) Vánky, Sydowia 34:170, 1981.

Burillia kamatii S.B. Thakur, Current Sci. 44:482, 1975. — Type on *Hygrophila serpyllum*, India, Maharashtra State, Kandala near Bombay, 26.VI.1972, S.B. Thakur, AMH 1005 (published as no. “1905”); isotypes IMI 178884, HUV 6457.

Sori on the leaves forming rounded or ellipsoidal, flat, first yellowish later brownish spots, 2-6 mm in diam. or larger by confluence, with spore ball in the host tissue appearing as minute, dark brown dots especially on the abaxial side of the leaves. *Spore balls* subglobose to broadly ellipsoidal, 100-180 × 110-200 µm, orange red tinted pale yellowish-brown, composed of a central mass of spores surrounded by a thin cortical layer of sterile cells. *Spores* varying in shape and size, rounded subpolyhedrally irregular, rarely elongated, 6-12 × 8-16 µm, pale cinnamon-yellow; wall even, c. 0.5 µm thick, smooth. *Cortex* 4-8 µm thick, medium dark cinnamon-yellow, composed of 1-2(-3) layers of tangentially flattened, empty cells, 5-20 µm long; wall c. 0.5 µm, smooth. *Spore germination* (Thakur, 1975:482; 1976:167) results of holobasidia with an apical whorl of 4-7 basidiospores which may conjugate in situ.

On *Acanthaceae*: *Hygrophila serpyllum* T. Anders.; S. Asia (India).

Study of the type specimen of *Doassansia khandalensis* on *Hemiadelphis* (*Acanthaceae*) showed that it belongs to the genus *Heterodoassansia*, as does *D. hygrophilae*, on *Hygrophila* (*Acanthaceae*; comp. Vánky, 2006b:56). A further species, *D. hemigraphidis* on *Hemigraphis latebrosa* Nees (*Acanthaceae*) from India (see below), could not be investigated due to the absence of type (*D. hemigraphiae*) and other specimens.

2. *Doassansia hemigraphidis* B.V. Patil & Thirum., Sydowia 20:49, 1968('1966'; as 'hemigraphiae').

Type on *Hemigraphis latebrosa* Nees, India, Maharashtra, Khandala, 20.IX.1959, B.V. Patil (type where?).

According to the original description "*Sori* foliicolous, forming yellow spots which enlarge to brownish patches, 6 to 10 mm diam. *Spore balls* permanently embedded in the mesophyll, globose to polygonal due to mutual compression on the sides, 100 to 250 μ in diameter. *Sterile* outer layer of cells hyaline to pale brown, smooth, rectangular, 9-14 $\times$ 14-21 μ , outer wall thickened, up to 2 to 4.5 μ . Inner fertile *spores* pale yellow, subglobose to polygonal, measuring 9-15 $\times$ 14-18 μ m, chiefly 10-15 μ m in diameter, thin-walled, smooth".

On *Acanthaceae*: *Hemigraphis latebrosa* Nees; S. Asia (India). Known only from the type locality.

No specimen of *Doassansia hemigraphiae* was available for study. A thorough study of the type or authentic material may show that it also belongs to the genus *Heterodoassansia*, similarly to the other two smuts on *Acanthaceae*, *H. hygrophilae* and *H. khandalensis*. In support of this assumption is the description "2-4.5 μ m thick outer wall" of the sterile cells, which probably refers to the tangentially flattened, narrow layer of small, empty, sterile cells, covering the large (ornamented?, inner layer of) sterile cells.

3. *Heterodoassansia hygrophilae* (Thirum.) Vánky, Mycotaxon 95:56, 2006.

For synonymy and description see Vánky (2006b:56).

4. *Heterodoassansia khandalensis* (S.D. Patil & Gandhe) Vánky, **comb. nov.**

MYCOBANK 510381.

Basionym: *Doassansia khandalensis* S.D. Patil & Gandhe, Maharashtra Vidnyan Mandir Patrika 10:33, 1975. — Type on *Hemiadelphis polysperma*, India, Maharashtra State, Khandala, 5.X.1971, S.D. Patil, HClO 32495; isotype HUV 15472! Topotype ibidem, on IX.1976, L.N. Nair, AMH, HUV 17457.

Sori on the leaves forming circular, elliptic or irregular spots, 1-5 mm in diam., first yellow, later pale brown, with spore balls embedded in the host tissue showing as minute, dark brown, hypophyllous dots. *Spore balls* globose, subglobose, broadly ellipsoidal, rarely irregular, 90-140 $\times$ 110-160 μ m, or larger by confluence, orange tinted pale yellowish-brown, composed of a central mass of spores surrounded by a cortex of empty, sterile cells. *Spores* rounded subpolyhedrally or polyhedrally irregular, varying in size, 7-10.5(-12) $\times$ 9-13.5 μ m, subhyaline or very pale yellowish-brown; wall even, c. 0.5 μ m thick, smooth. *Cortex of sterile cells* of two kinds: an inner layer of larger, globoid, ellipsoidal, radially elongated or irregular cells, measuring 5-15 $\times$ 8-20 μ m, pale yellowish-brown; wall even, c. 0.5 μ m thick, sparsely to moderately densely, finely, low verrucose-echinulate on its inner surface. The second, outermost layer of the cortex is formed of small, radially flattened, irregular cells of the

same colour and wall thickness as the inner layer but lacking ornamentation. *Spore germination* (Patil & Gandhe, 1976:31) results in holobasidia with an apical whorl of 4-8 basidiospores which produce secondary sporidia or, after conjugation, dicaryotic hyphae.

On *Acanthaceae*: *Hemiadelphis polysperma* Nees; S. Asia (India).

Heterodoassansia khandalensis differs from the closely related *H. hygrophilae* by having smaller spore balls, spores and cortical cells, by more finely ornamented cortical cells, and by different host plant genera. It is likely they represent the same species (molecular biology?).

Key to the smut fungi of *Acanthaceae*

1. Cortex of spore balls composed of one kind of sterile cells 2
- Cortex of spore balls composed of two kind of sterile cells 3
2. Cortical layer thin (4-8 μm). *Doassansia kamatii*
- Cortical layer thick (14-21 μm). *Doassansia hemigraphidis*
3. Spore balls 110-200 μm long; spores 9-16 μm long; sterile cells finely, low verrucose-echinulate. *Heterodoassansia khandalensis*
- Spore balls 110-160 μm long; spores 9-13 μm long; sterile cells with 0.5-1 μm high spines *Heterodoassansia hygrophilae*

Tilletia species on *Poa* (*Poaceae*)

Poa L., in the subfamily *Pooideae*, tribe *Poeae*, with c. 500 species throughout the world, is an extremely uniform genus (Clayton & Renvoize, 1986:101). On *Poa* only five *Tilletia* species are recognised. Some of them, very typical ones, occur also on other un-related host genera. Several *Tilletia* species on *Poa* have been collected once or a few times only. They can be overlooked but in some cases they seems to be geographically restricted (e.g. *T. togwateei*).

1. *Tilletia cathcartae* Durán & G.W. Fisch., The genus *Tilletia*: 44, 1961.

Type on *Poa caespitosa* G. Forst., Australia, New South Wales, Cathcart, 14.I.1940, J.

Vickery, NSW 9039; isotypes BRIP 7807!, WSP 48366, HUV 18645!

Sori in all ovaries of an inflorescence, inconspicuous, hidden by the floral envelopes, ovoid to broadly fusiform, c. 0.5 $\times$ 1-1.5 mm, at first covered by the pericarp which ruptures disclosing the reddish-brown, powdery spore masses intermixed with sterile cells. *Spores* globose, subglobose to broadly ellipsoidal or slightly irregular, 30-36 $\times$ 32-42 μm , golden-brown; wall 4-5 μm thick including the 3-4 μm high, flattened verrucae which may give the spore surface an areolate aspect. *Sterile cells* few, globose, irregular or angular, 18-30 μm in diam., hyaline; wall 3.5-5 μm thick, smooth.

On *Poa caespitosa* G. Forst., *Poa clivicola* Vickery, *Poa ensiformis* Vickery, *Poa pusilla* Bergg.; Australasia (Australia, New Zealand).

2. *Tilletia paradoxa* Jacz., Zap. Naucno-Prikl. Otd. Tiflisk. Bot. Sada 5:169, 1926.

Type on *Phleum* sp. Russia, Transcaucasia, between Ipchreuli and Dioban, 19.VIII.1910, H. Popov; isotypes AA! (originating from Tiflis), HUV 12133!

Tilletia transiliensis Kuznetzova & Schwarzman, in Schwarzman, Fl. spor. rast. Kazakhstana 2:240, 1960. — Type on *Poa nemoralis* L., Kazakhstan, Reg. Alma-Ata, Mt. Zailijskij Alatau, valley Kazachki, 8.X.1957, S.R. Schwarzman, AA!; isotype HUV 12132! (syn. by Vánky, 1988a:403).

Tilletia sabaudiae H. Zogg, Botanica Helvetica 93:91, 1983. — Type on *Poa nemoralis* L., France, Savoie Prov., "in Alpihus Sabaudiae" [= Savoier Alpen], 1851, J. Müller-Argoviensis, NEU; isotype HUV 10918! (syn. by Vánky, 1988a:403).

Sori in all ovaries of an inflorescence, as minute, dark bodies, partially hidden by the glumes and covered by a delicate pericarp which ruptures disclosing the black, granular-powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid to occasionally ellipsoidal, opaque, dark reddish-brown, very large, $37\text{--}52 \times 37\text{--}58\ \mu\text{m}$, including the $4\text{--}6\ \mu\text{m}$ high corona (measured in lactophenol); wall in LM appear obscurely reticulate, 6–10 meshes per spore diam., meshes irregularly polyhedral to subpolyhedral, $1.5\text{--}5.5\ \mu\text{m}$ in diam., muri finely verruculose, $0.5\text{--}1.5\ \mu\text{m}$ high. Corona around the spores yellow-tinted, with ridges that are erect or curved in one direction (optical phenomenon?). In SEM the spores appear with dense, often narrow tubercules. *Sterile cells* globose to ovoid, variable in size, smaller than the spores ($10\text{--}30\ \mu\text{m}$ long), with granular contents; wall hyaline with a yellowish tint, smooth, sometimes unevenly thickened, $3\text{--}7\ \mu\text{m}$ wide.

On *Phleum* sp., and *Poa nemoralis* L.; Europe, Asia.

3. *Tilletia poae* Nagorny, Sci. Papers Appl. Sec. Tiflis Bot. Gard. 5:170, 1926.

Type on *Poa nemoralis* var. *svanetica* Hack., Russia, Caucasia, Svanetiya, Dongusorum Glacier, 16.VIII.1925, N. Ketzchoveli, ?

Sori in ovaries, more or less hidden by the enveloping glumes, first covered by the pericarp which ruptures exposing the dark brown, semi-powdery, foetid mass of spores. *Spores* globose, subglobose, $24\text{--}27 \times 25\text{--}29\ \mu\text{m}$ in diam., including the $2\text{--}2.5\ \mu\text{m}$ thick sheath, light olivaceous-brown; wall with complete or incomplete reticulum, 6–8 meshes per spore diam., often with a tuberculum in the interspace. *Sterile cells* globose to ovoid, smaller than the spores (mostly $12\text{--}17\ \mu\text{m}$ long), hyaline, with granular content and a smooth, $1\text{--}2\ \mu\text{m}$ thick wall.

On *Poa nemoralis* L., *P. nemoralis* var. *svanetica* Hack.; Europe, Asia.

The spores of *T. poae* were originally described as measuring $30\text{--}35\ \mu\text{m}$. Having not seen the type of *T. poae*, I based my description on a specimen collected NE of Moscow (Yaroslavskaya Region, Galich Raion, near Mateevo, 28.VII.1928, M. Makaveev, LEP). A specimen in AA, labelled as *T. poae*, collected by Nagorny in the type locality but one year later (1926), contains typical *T. paradoxa* (wrongly labelled or mixed specimen?).

4. *Tilletia sterilis* Ule, Verh. Bot. Vereins Prov. Brandenburg 5:214, 1884.

Ustilago sterilis (Ule) Nannfeldt, in Lindeberg, Symb. Bot. Upsal. 16(2):151, 1959.
— Lectotype (designated by Liro, 1938:75) on *Koeleria cristata* (L.) Pers., p.p. (= *K. pyramidata* (Lam.) P. Beauv.), Germany, Bavaria [= Bayern], Coburg, Rögner Berg, VII.1879, E. Ule; isoelectotypes in Rbh. Fgi. eur. no. 3605, HUV 2425!

Tilletia scrobiculata G.W. Fisch., Res. Stud. St. Coll. Wash. 20:6, 1952. — Type on *Poa secunda* J. Presl, USA, Idaho, McCall, 1.VIII.1948, G.W. Fischer, R. Sprague & J.P. Meiners; isotypes in Fischer, Gramin. smuts N. Amer. no. 221, HUV 10003! Paratype: Idaho, Latah Co., 5.VII.1950, R. Sprague & G.W. Fischer; isoparatypes in Fischer, Gramin. smuts N. Amer. no. 268, HUV 10004! (syn. by Vánky, 1994:252).

Sori in leaves, sheaths and culms as long, inconspicuous striae between the veins which may cover the whole leaf surface, initially yellowish-grey, later reddish-brown or dark brown. Attacked plants dwarfed and usually not flowering. Spore mass golden-brown, agglutinated to semi-powdery, foetid. *Spores* globose, subglobose, ovoid to slightly irregular, $17-24 \times 19-30 \mu\text{m}$, light golden- to medium dark brown, with granular contents; wall two-layered, endospore $0.5-1 \mu\text{m}$ thick, exospore obscurely reticulate, often appearing as pitted or papillate, 8-20 meshes per spore diam., muri $1-2.5 \mu\text{m}$ high. *Sterile cells* rare, globose to irregular, smaller than the spores, hyaline to yellow tinted; wall thin ($0.5-1.5 \mu\text{m}$). *Germination* of *Tilletia* type (Meiners, 1957:528; Dumitraş, 1971:187).

On *Festuca ovina* L., *F. valesiaca* Schleich. ex Gaudin, *Festuca* sp., *Koeleria pyramidata* (Lam.) P. Beauv. (*K. cristata* (L.) Pers., p.p.), *Poa nemoralis* L., *Poa secunda* J. Presl; Europe, N. America.

5. *Tilletia togwateei* Guillem., Mycologia 80:284, 1988 (as '*togwatii*').

Type on *Poa reflexa* Vasey & Scribn., USA, Wyoming, Togwatee Pass, 12.VIII.1948, G.W. Fischer, WSP 85654. Topotype: 4.VIII.1992, P. Gray & L. Carris, WSP 85654, isotopotype HUV 18090!

Sori in the ovaries, infecting all in the inflorescence, ovoid with acute tip, $0.5-0.7 \times 1-2 \text{ mm}$, more or less hidden by the floral envelopes, covered by the thin, brown pericarp which ruptures irregularly disclosing the almost black, powdery, foetid mass of spores and sterile cells. *Spores* subglobose, ovoid, ellipsoidal to slightly irregular, $17.5-24 \times 21-28 \mu\text{m}$, yellowish- to medium dark brown; wall reticulate, very often incompletely so, often appearing cerebriform, 7-12 meshes per spore diam. (spores with cerebriform ornamentation not counted), muri $1-2.5 \mu\text{m}$ high, in optical median view blunt or acute. *Sterile cells* subglobose, ovoid, ellipsoidal to subpolyhedrally slightly irregular, $9-16 \times 11-18(-21) \mu\text{m}$, hyaline to subhyaline; wall even, $1.5-3 \mu\text{m}$ thick, smooth.

On *Poa reflexa* Ell. ex Scribn.; N. America (USA).

In the collection (BPI 172694), the spores are small ($18.5-25 \mu\text{m}$ long) and the muri are low ($0.8-1.5 \mu\text{m}$ high) and blunt.

Key to the *Tilletia* species of *Poa*

1. Sori in the leaves or stems forming inconspicuous striae *T. sterilis*
- Sori in the ovaries 2
2. Spores 37-58 µm long *T. paradoxa*
- Spores smaller 3
3. Spores 32-42 µm long, with 3-4 µm high, flattened verrucae *T. cathartae*
- Spores between 21-29 µm long, reticulate, often incompletely 4
4. Meshes 6-8 per spore diam. *T. poae*
- Meshes 7-12 per spore diam., surface often cerebriform *T. togwateei*

Stripe smuts of *Calamagrostis* (incl. *Deyeuxia*; *Poaceae*)

Calamagrostis Adans. and *Deyeuxia* P. Beauv. are two closely related genera in the subfam. *Pooideae*, tribe *Aveneae*, subtribe *Alopecurinae*. Clayton & Renvoize (1986:135) considered they were synonyms. Several smut fungi producing long striae on the leaves, leaf sheaths, culms and even in the inflorescence have been described on various species of *Calamagrostis*. Of these, *Urocystis calamagrostidis* (Lavrov) Zundel (Zundel 1953:312), is characterised by spore balls in which the spores are surrounded by sterile cells. *Ustilago* species, possessing single spores, reported on *Calamagrostis* (and *Deyeuxia*) are: 1. *U. calamagrostidis* (Fuckel) G.P. Clinton (Clinton 1902:138), 2. *U. corcontica* (Bubák) Liro (Liro 1924:383), 3. *U. deyeuxiae* L. Guo (Guo 1993:51), 4. *U. deyeuxiicola* Vánky & L. Guo (Vánky & Guo 2001:262), 5. *U. scrobiculata* Liro (Liro 1924:68), 6. *U. striiformis* (Westend.) Niessl (Niessl 1876:1). These species can be differentiated by spore morphology (For descriptions and illustrations of most of these species see Vánky, 1994). The main distinctive characters are shown in a key below. The single problem is presented by no. 2 and 6 (*U. corcontica* and *U. striiformis*). Bubák (1912, 1916) recognised three species: no. 1, 2 and 6 (all as '*Tilletia*'). Nannfeldt (Lindeberg, 1959:154-156) studied in detail the stripe smuts of *Calamagrostis* and concluded that, at least in Europe, only three species occur: no. 1, 2 and 5. At the same time, he wrote that he was unable to find no. 6.

U. striiformis sensu latissimo is a polyphageous, cosmopolitan species infecting a large number of host plants in at least 40 genera, between them also *Calamagrostis*. There are certainly specialised forms confined to certain host species or genera. Moreover, spore shape, size and ornamentation also vary markedly between specimens infecting different host genera, the same host genus (comp. also Mäkinen, 1963), or even the same host species. Due to the lack of a comparative study of this group, and because of the presence of intermediate forms, I treated *U. striiformis* in a broad sense (Vánky, 1985:237-241; 1994:377-379) and included in it *U. corcontica*. In a recent paper, Spooner & Legon (2006:92-93) considered *U. corcontica* as a separate species, "closely

akin to *U. calamagrostidis*". For the length of the spores they gave 12-16(-19) μm (without ornament), and c. 0.8-1 μm high spines. I strongly suspect that this species, on *Calamagrostis canescens*, is actually *U. calamagrostidis*. Study of the whole complex of *U. striiformis* s. lat. by modern methods, i.e. morphological characters combined with molecular ones, related to host plants, certainly will reveal several, more or less well-delimited taxa.

Key to the stripe smuts of *Calamagrostis* (incl. *Deyeuxia*)

1. Spores in balls surrounded by sterile cells *Urocystis calamagrostidis*
- Spores single, sterile cells absent 2
2. Spores 12-19 μm long, coarsely ornamented 3
- Spores smaller, more finely ornamented 4
3. Spores with irregular warts, the bases of which are confluent into irregular, interrupted meshes *Ustilago scrobiculata* (incl. *U. deyeuxiae*)
- Spores with regular, isolated spines, up to 1 μm long .. *Ustilago calamagrostidis*
4. Spores 9-15(-16) μm long, densely echinulate; spore profile serrulate *Ustilago striiformis* (incl. *U. corcontica*)
- Spores 6.5-10 μm long, finely verruculose; spore profile smooth *U. deyeuxiicola*

NEW SPECIES

Two new species of *Tilletia*

Cîrțu et al. (1974) published several microfungi from Romania, including also «*Tilletia melicae* Lagerh., in Sacc. Syll. Fung. VII, 2, 490, 1888 on *Melica cilata* L. subsp. *transsilvanica* (Schur) Husnot". Neither Lagerheim, nor anyone else appears to have published this name. Thirty years ago, Dr. Cîrțu sent me a small part of the collection, preserved in his herbarium. A study of the fungus revealed that it represents a new species:

Tilletia melicae Vánky, sp. nov.

MYCOBANK 510358

Typus in matrice Melica transsilvanica Schur, Romania, Oltenia, Comit. Dolj, prope pag. Dilga, in silvis, alt. cca. 100 m.s.m., 16.VIII.1966, leg. D. et M. Cîrțu. Holotypus in Herbario Ustil. Vánky, HUV 2355!, isotypus in Herb. Cîrțu.

Sori in ovariis omnibus(?) eiusdem inflorescentiae, ovoideae vel ellipsoidales, cca. 1 mm longi, involucris floralibus perfecte occulti, primo pericarpio tenui cooperti, quo irregulariter rupto massam proprie foetidam, rubrobrunneam, pulveream sporarum et cellularum steriliū ostendentes. Sporae globosae, subglobosae usque late ellipsoidales, 16-20 × 16-21,5 μm , pallide flavidobrunneae, reticulatae; maculis raro incomplete polyangularibus 4-7 per diametrum sporae, muri etiam in visu opticali mediano conici, 1-1,5 μm alti, acuti, 18-24 in circumferencia aequatoriali. Cellulae steriles globosae, ellipsoidales usque parum irregulares, 8-15 × 9-17 μm , subhyalinae vel flavide tinctae; pariete 1-2 μm crasso, levi vel cum spuris ornamenti.

Sori in all(?) ovaries of an inflorescence, ovoid or ellipsoidal, c. 1 mm long, completely hidden by the floral envelopes, first covered by the thin pericarp which ruptures irregularly disclosing the foetid, reddish-brown, powdery mass of spores and sterile cells. *Spores* (Figs. 10, 11) globose, subglobose to broadly ellipsoidal, $16\text{--}20 \times 16\text{--}21.5 \mu\text{m}$, pale yellowish-brown, reticulate, meshes polyangular, rarely incomplete, 4-7 per spore diam., muri in optical median view conical, $1\text{--}1.5 \mu\text{m}$ high, acute, 18-24 on the equatorial circumference. *Sterile cells* (Fig. 10) globose, ellipsoidal to slightly irregular, $8\text{--}15 \times 9\text{--}17 \mu\text{m}$, subhyaline or with a yellow tint; wall $1\text{--}2 \mu\text{m}$ thick, smooth or with a trace of ornament.

On *Poaceae*: *Melica transsilvanica* Schur; Europe (Romania). Known only from the type locality.

Typical for *Tilletia melicae* are: host plant in the tribe *Meliceae* (of the subfam. *Pooideae*), the reticulated spores with conical, $1\text{--}1.5 \mu\text{m}$ high, acute muri, 18-24 on the equatorial circumference. It differs mainly from the similar *T. contraversa*, in which the muri are $1.5\text{--}3 \mu\text{m}$ high, embedded in a hyaline sheath, from *T. caries*, with 5-8 meshes per spore diam., muri $0.5\text{--}1.5 \mu\text{m}$ high, blunt or subacute, and from *T. bromi*, in which the muri are $1.5\text{--}2.5 \mu\text{m}$ high, 21-29 on the equatorial circumference.

Tilletia shivasii Vánky, sp. nov.

MYCOBANK510359

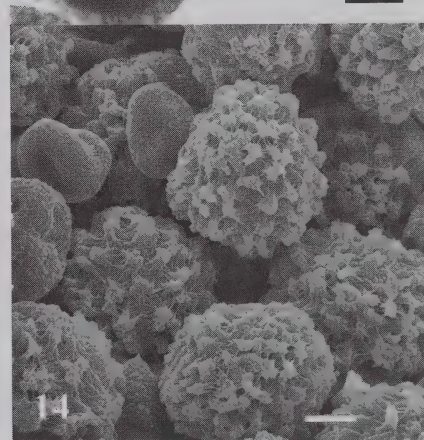
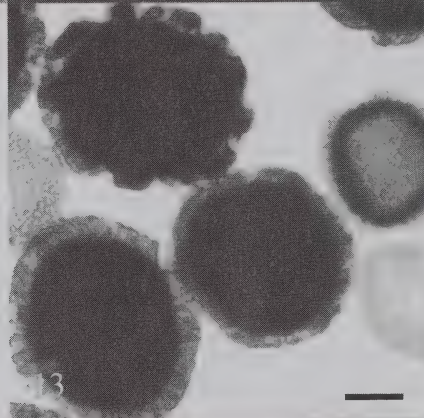
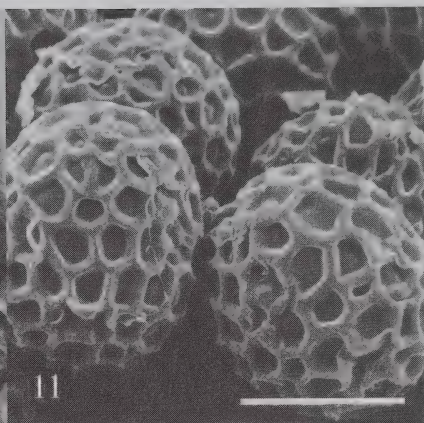
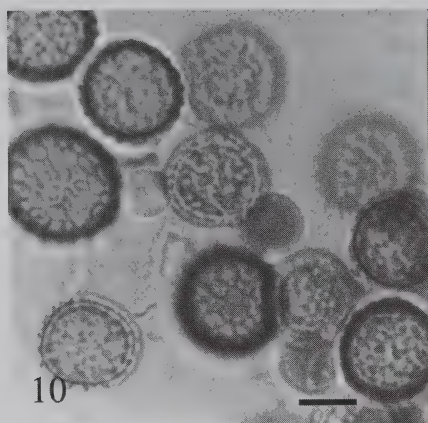
Typus in matrice *Arundinella nepalensis* Trin., Australia, Northern Territory, 13 km W urbe Batchelor, $13^{\circ}03'09''\text{S}$, $130^{\circ}54'51''\text{E}$, alt. cca. 140 m.s.m., 8.VI.2006, leg. M.J. Ryley, M.D.E. & R.G. Shivas. Holotypus in BRIP 47951, isotypus in Herbario Ustil. Vánky, HUV 21367! (unacum *Macalpinomyces arundinellae-setosae* R.G. Shivas & Vánky).

Sori in ovariis nonnullis eiusdem inflorescentiae, ovoidei, $0,8\text{--}1 \times 1,5\text{--}2 \text{ mm}$, inter involucris floralibus patentibus conspicui, primo peridio laeve, pallide brunneo, origine hostali cooperti, quo irregulariter rupto massam nigram, semiagglutinatam usque pulveream sporarum cellulis sterilibus intermixtam ostendentes. Sporae globosae, subglobosae usque late ellipsoidales, $28\text{--}36 \times 30\text{--}40 \mu\text{m}$, atro-badiae usque opacae, cum grossis projecturis cylindricis irregularibus, $3,5\text{--}6,5 \mu\text{m}$ longis, in aspectu superficiali sicut maculae atrae, irregulares, polyangulares, in diametro sporae 8-10, in aspectu medio opticali cylindricis, apice rotundatis, complanatis vel parum dilatatis, 28-40 in circumferentia aequatoriali. Cellulae steriles globosae, ovoideae, ellipsoidales usque parum irregulares, $12\text{--}28 \times 13,5\text{--}29 \mu\text{m}$, pallide olivaceobrunneae; pariete aequali, $2,5\text{--}6 \mu\text{m}$ crasso, multistratoso, levi vel verruculoso, saepe cum appendice breve hyphali.

Figs. 10, 11. Spores and sterile cells of *Tilletia melicae* on *Melica transsilvanica* in LM and in SEM (type). Bars = 10 μm .

Fig. 12. A sorus of *Tilletia shivasii* in the ovary of *Arundinella nepalensis* (type). Bar = 1 mm.

Figs. 13, 14. Spores and sterile cells of *Tilletia shivasii* on *Arundinella nepalensis* in LM and in SEM (type). Bars = 10 μm .



Sori (Fig. 12) in some ovaries of an inflorescence, ovoid, $0.8\text{--}1 \times 1.5\text{--}2$ mm, showing between the spreading floral envelopes, at first covered by a pale brown, smooth peridium of host origin which ruptures irregularly disclosing the black, semiagglutinated to powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 13, 14) globose, subglobose to broadly ellipsoidal, $28\text{--}36 \times 30\text{--}40$ μm , dark chocolate-brown to opaque, provided with coarse, $3.5\text{--}6.5$ μm long, irregularly cylindrical projections, in surface view showing as dark, irregular, polyangular spots, 8–10 per spore diameter, in optical median view appearing cylindrical, with rounded, flattened or slightly widened tip, $28\text{--}40$ on the equatorial circumference. *Sterile cells* (Figs. 13, 14) globose, ovoid, ellipsoidal to slightly irregular, $12\text{--}28 \times 13.5\text{--}29$ μm , pale olivaceous-brown; wall even $2.5\text{--}6$ μm thick, multilayered, smooth or verruculose, often with a short hyphal appendage.

On *Poaceae*: *Arundinella nepalensis* Trin.; Australia. Known only from the type locality.

Etymology: This species is named after Dr. Roger G. Shivas (Brisbane, Australia), the most active investigator of the smut fungi of Australia, passionate collector of microfungi in many countries worldwide, author of numerous new species and genera, co-author of the monograph of the smut fungi of Australia, who also collected this smut fungus.

Key to the *Tilletia* species of *Arundinella*

1. Sori 10–30 mm long, hispid; spores with $1\text{--}1.5\text{--}(2)$ μm high warts *T. chiangmaiensis*
- Sori up to 5 mm long, smooth; spores with higher warts 2
2. Sori obovoid, with two longitudinal stripes; spores $20\text{--}27\text{--}(30)$ μm long; warts $1.5\text{--}2.5$ μm high *T. lineata*
- Sori ovoid, without longitudinal stripes; spores larger; warts higher 3
3. Spores $22\text{--}33\text{--}(37)$ μm long; warts $1.5\text{--}3$ μm high *T. arundinellae*
- Spores $30\text{--}40$ μm long; warts $3.5\text{--}6.5$ μm high *T. shivasii*

A new species of *Restiosporium* on *Guringalia* (*Restionaceae*)

Some smutted *Guringalia dimorpha* are preserved in DAR. The smut was studied and compared to the 20 known *Restiosporium* species on *Restionaceae* (comp. Vánky, 2006a) revealing a new species:

Restiosporium guringaliae Vánky & R.G. Shivas, sp. nov.

MYCOBANK510362.

Typus in matrice *Guringalia dimorpha* (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, New South Wales, Sydney, North Bondi, Williams Park, $33^{\circ}52'S$, $151^{\circ}16'E$, 23.VI.1960, leg. O.D. Evans & E.F. Constable. *Holotypus* in DAR 7048, *isotypi* in BRIP 48219 et in HUV 21278. *Paratypus in matrice* *Guringalia dimorpha*, Australia, New South Wales, Sydney, Bondi, 25.X.1916, leg. A.A. Hamilton, DAR 2201.

Sori inconspicui, *semina* destruentes, *capsulas* massa nigra, granuloso-pulverea glomerulorum sporarum complementes. Infectio systemica; capsulae omnes plantae eiusdem affectae. Glomeruli sporarum globosi, ovoidei-ellipsoidales vel parum irregulares, $40\text{--}100 \times 50\text{--}120\text{--}(150) \mu\text{m}$, atro-olivaceobrunnei usque opaci, e sporis pluries decem usque pluries centum pressu leviter separabilibus compositi. Sporae rotundatae usque elongatae, subpolyedrice vel polyedrice irregulares, $7.5\text{--}10.5 \times 9\text{--}14\text{--}(16) \mu\text{m}$, pallidee olivaceobrunneae cum lineis atrioribus correspondentibus marginibus laterium contactorum; pariete aequali, cca. $0.5 \mu\text{m}$ crasso, in LM levi, in SEM superficies libera sporarum maxime externarum glomeruli aspera, cum verrucis humilibus, irregularibus, rotundatis, confluentibus instructa.

Sori (Fig. 15) inconspicuous, destroying the seeds, filling the capsules with a black, granular powdery mass of spore balls. Infection systemic; all capsules of a plant are affected. *Spore balls* (Figs. 17, 18) globose, ovoid ellipsoidal or slightly irregular, $40\text{--}100 \times 50\text{--}120\text{--}(150) \mu\text{m}$, dark olivaceous-brown to opaque, composed of tens to hundreds of spores which separate easily by pressure. *Spores* (Figs. 17, 18) rounded to elongated, subpolyhedrally or polyhedrally irregular, $7.5\text{--}10.5 \times 9\text{--}14\text{--}(16) \mu\text{m}$, pale olivaceous-brown with darker lines corresponding to the edges of contact sides; wall even, c. $0.5 \mu\text{m}$ thick, in LM smooth, in SEM the free surface of the outermost spores in a ball is rough, provided with low, irregular, rounded, confluent warts.

On *Restionaceae*: *Guringalia dimorpha* (R. Br.) B.G. Briggs & L.A.S. Johnson (*Restio dimorphus* R. Br.), Australia. Known only from the type collections.

The differentiating morphological characters of the *Restiosporium* species are often small. It seems that there is a host specificity (Vánky, 2006a:20). *R. guringaliae* differs from *R. anarthriae* Vánky (on *Anarthria*) in which the spore balls are smaller ($40\text{--}80 \mu\text{m}$ long), the spores are paler, and their wall is thicker ($0.5\text{--}1 \mu\text{m}$); from *R. baloskionis* Vánky & R.G. Shivas (on *Baloskion*) in which the spores are larger ($9\text{--}17\text{--}(20) \mu\text{m}$); from *R. chaetantherae* Vánky (on *Chaetanthera*) in which the spore balls are more persistent and paler, the spore wall is slightly uneven, $0.5\text{--}1 \mu\text{m}$ thick; from *R. flexuosum* Vánky (on *Desmocladus*) in which the spore balls are ephemeral, and the spore wall is thicker ($0.5\text{--}1.5 \mu\text{m}$); from *R. pallentis* Vánky & R.G. Shivas (on *Baloskion*) in which the spore balls are smaller ($30\text{--}90\text{--}(100) \mu\text{m}$ long) and the spore walls uneven, $0.5\text{--}1 \mu\text{m}$ thick; from *R. sphacelatum* Vánky (on *Chordifex*) in which the spore balls are more persistent, the spores more rounded and uniformly pigmented. *R. guringaliae* morphologically is closest to *R. meneyae* Vánky (on *Lyginia*) which has spores that appear in SEM smooth or extremely finely, sparsely, low verruculose.

A new species of *Franzpetrakia* on *Phacelurus* (*Poaceae*)

A peculiar smut fungus was collected by M.S. Pavgi in India on *Microstegium* sp., destroying the whole inflorescence. The spore mass is powdery, interwoven by numerous long, slender, fragile chains of sterile fungal cells, the spores are

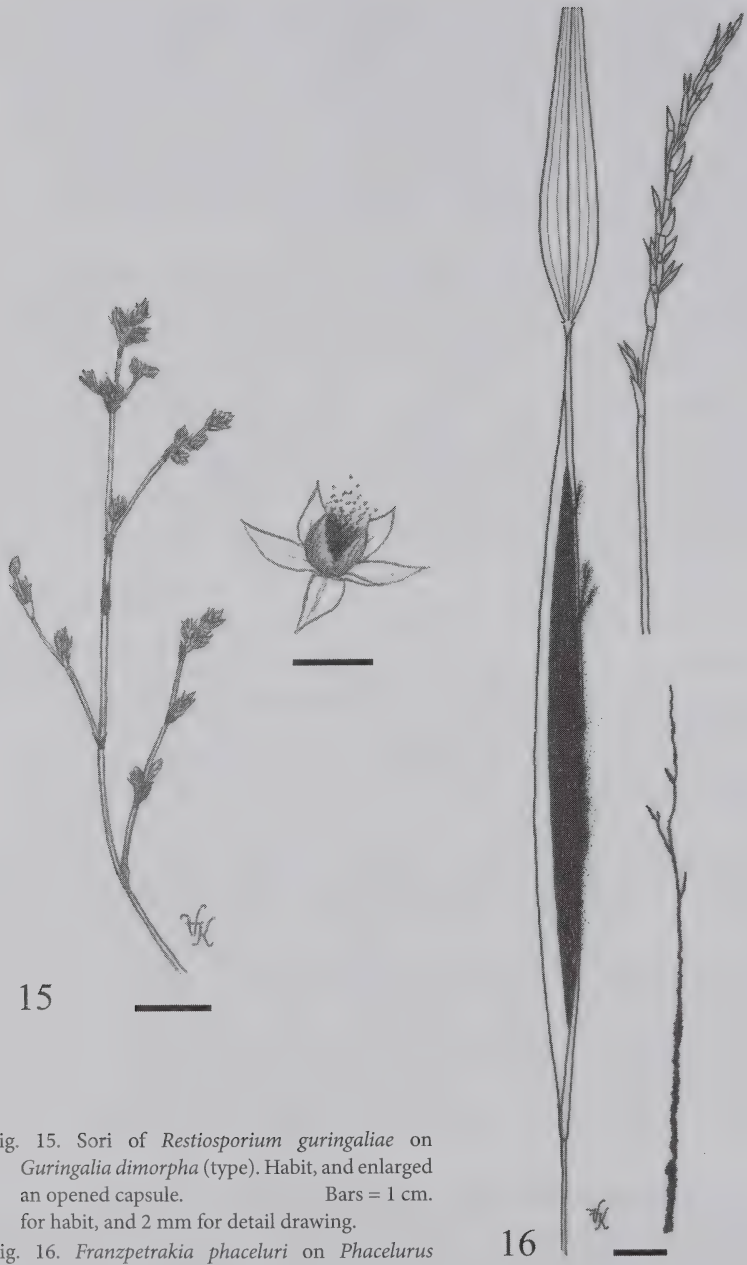


Fig. 15. Sori of *Restiosporium guringaliae* on *Guringalia dimorpha* (type). Habit, and enlarged an opened capsule. Bars = 1 cm. for habit, and 2 mm for detail drawing.

Fig. 16. *Franzpetrakia phaceluri* on *Phacelurus latifolius* var. *monostachyus* (type). Habit, and a healthy inflorescence. Bar = 1 cm.

characteristically reticulate. A new genus, *Franzpetrakia* Thirum. & Pavgi (Pavgi & Thirumalachar 1957:2) was proposed to accommodate it, with the type *F. microstegii* Thirum. & Pavgi. The genus was studied and emended by Guo et al. (1990:58), when a second species was added, *F. okudairae* (Miyabe) L. Guo et al. on *Coix lacryma-jobi* L., from Japan and China. Smutted *Phacelurus latifolius* var. *monostachyus* was collected in China by L. Guo, and later by R.G. Shivas. Based only on the original description, this specimen was provisionally identified by Guo et al. (1990) as *F. microstegii*. A comparison with the type was not possible, because it is apparently lost. Recently, smutted *Microstegium vagans* (Nees ex Steud.) A. Camus was collected in Thailand, Kanchanaburi Prov., 13 km SE of Sangkhla Buri, alt. 325 m, 16.XII.2005, leg. R.G., M.D.E., A.J. & G.E. Shivas, P. Athipunyakom, S. Likhitekaraj, A. Somrith, T. Bashabutra, C. & K. Vánky, BRIP 47760, HUV 21217. A comparison of this specimen with that on *Phacelurus latifolius* from China revealed that they are different. The specimen on *Microstegium vagans* is considered to be *F. microstegii*, whereas the smut on *Phacelurus* is described as a new species:

***Franzpetrakia phaceluri* Vánky, R.G. Shivas & L. Guo, sp. nov.**

MYCOBANK510361

Typus in matrice Phacelurus latifolius var. *monostachyus* (det. Zhou Gen-sheng), China, Yunnan Prov., Kunming, Hot Springs, 28.IX.1987, leg. L. Guo. Holotypus in HMAS 58388, isotypus in Herbario Ustil. Vánky, HUV 13861. Paratypus ibidem, 3.XI.2002, leg. R.G. Shivas & H.E.C. Evans, BRIP 39203, isoparatypus HUV 20192.

Franzpetrakia phaceluri a specie simili *F. microstegii* sporis aliquantum majoribus (13-18,5 μm longis), et caractere muri latoris (0,5-1,5 μm), reticulis parvis plerumque multis, muris 12-18 in aequatoriali circumferentia distincta. Catenae cellularum sterilium etiam latiores (8-14 μm), saepe cellulis 2 vicinis compositae. Sporae *F. microstegii* 12-16 μm longae, muri reticuli cca. 0,5 μm lati, raro reticulo pusillo, 10-15 in aequatoriali circumferentia. Catenae cellularum sterilium 5,5-11 μm latae, e serie singulo cellularum compositae.

Sori (Fig. 16) destroying the whole inflorescence, fusiform, 0,5-2 $\times$ 5-10 cm, at first concealed by the uppermost leaf sheath, later protruding as dark brown, powdery mass of spores intermixed with numerous slender, filiform chains of sterile fungal cells surrounding a central, ramified columella of host origin. *Spores* (Figs. 19, 20) globose, ovoid or ellipsoidal, 11-17,5 $\times$ 13-18,5 μm , olivaceous-brown, reticulate, meshes complete, rarely incomplete, polyangular or subpolyangular, (2-)3-4 per spore diam., muri 0,5-1,5 μm wide, (1-)1,5-2,5(-3) μm high, with flattened tip, 12-18 on the equatorial circumference, in SEM muri wide, often with numerous minute, irregular meshes in groups, evident especially in SEM. *Chains of sterile cells* (Figs. 19, 20) 8-14 μm wide, several mm long, composed usually of a single, not rarely also a double row of fungal cells. Cells of the chains variable in shape and size, oblong with both ends truncate, subtetrahedral or subglobose, 5-9 $\times$ 8-12 μm , subhyaline or with a

pale yellowish-brown tint; wall 0.5-1 μm thick, apparently smooth, in SEM free surface finely verruculose.

On *Poaceae*: *Phacelurus latifolius* var. *monostachyus* Keng; S.E. Asia (China). Known only from the type locality.

Franzpetrakia phaceluri differs from the similar *F. microstegii* (type on *Microstegium* sp., India), by having larger spores, less meshes per spore diam., and by wider muri with numerous small reticula, as well as by wider chains of sterile cells, often composed of two cells side by side. In *F. microstegii* the spores are 12-16 μm long, with 2-5 meshes per spore diam., the muri of the reticulum are c. 0.5 μm wide, rarely with small reticula, the chains of sterile cells are 5.5-11 μm wide, composed of a single row of cells.

Key to the species of *Franzpetrakia*

1. Spores often incompletely reticulate; muri on the equatorial circumference 14-23; sterile cells 8-17.5 μm wide. On *Coix*. *F. okudairae*
- Spores rarely incompletely reticulate; muri on the equatorial circumference less; sterile cells smaller. Not on *Coix*. 2
2. Muri on the equatorial circumference 12-18, 0.5-1.5 μm wide, with flattened tip, often with numerous, minute reticula; sterile cells 8-12 μm wide. On *Phacelurus* *F. phaceluri*
- Muri on the equatorial circumference 10-15, c. 0.5 μm wide, with rounded tip, rarely with minute reticula at the angles; sterile cells 5.5-7(-10.5) μm wide. On *Microstegium* *F. microstegii*

A new species of *Sporisorium* on *Ischaemum* (*Poaceae*)

Samples of *Ischaemum indicum*, infected by a *Sporisorium* sp., were collected in Myanmar (Burma) by Dr. R.G. Shivas (Brisbane, Australia). The fungus differs from all ten known *Sporisorium* species on *Ischaemum* (comp. Vánky, 2004:94-102), including the recently published *S. ischaemianum* A.R. Patil et al. (Patil et al. 2004a:783). It is described as:

Sporisorium myanmarensis Vánky & R.G. Shivas, sp. nov.

MYCOBANK 510363.

Typus in matrice *Ischaemum indicum* (Houtt.) Merr. (det. H. Scholz, B), Myanmar (Burma), Yangon (Rangoon), ad lacum Inaya, 16°50'12.7" N, 96°09'15.7" E, 23.III.2006, leg. R.G. Shivas. *Holotypus* in HUV 21333, *isotypus* in BRIP 47943.

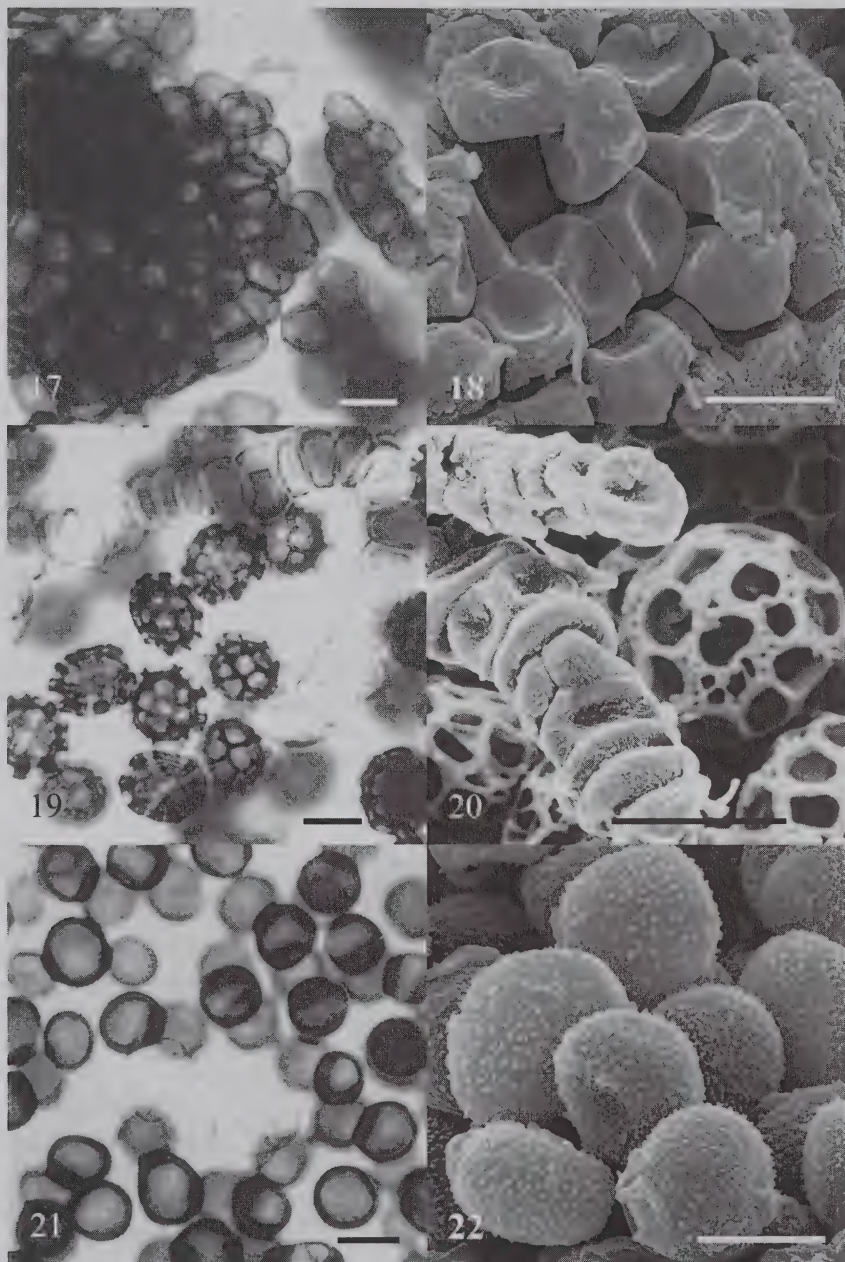
Sori in spiculis omnibus eiusdem inflorescentiae, ovoidei vel ellipsoidales, 1,5-2 mm longi, primo peridio pallide brunneo cooperti, quo irregulariter rupto, massam atrobrunneam,

Figs. 17, 18. Spore balls and spores of *Restiosporium guringaliae* on *Guringalia dimorpha* in LM and in SEM (type).

Figs. 19, 20. Spores and chains of sterile cells of *Franzpetrakia phaceluri* on *Phacelurus latifolius* var. *monostachyus* in LM and in SEM (type).

Figs. 21, 22. Spores of *Sporisorium myanmarensis* on *Ischaemum indicum* in LM and in SEM (type).

Bars = 10 μm .



pulveream sporarum cellulis sterilibus intermixtam, columellam crassam, centralem decrescentem, saepe ramulis 1-2, brevibus, spiniformibus apicalibus instructam cingentem ostendentes. Sporae maturae singulae, globosae, subglobosae, ovoideae vel late ellipsoidales, non subpolyangulares, magnitudine variae, 8-12 × 9-14,5(-16) µm, mediocriter atro-flavidobrunneae; pariete aequali, 0,5-1 µm crasso, leniter, aliquantum dense echinulato, imago obliqua sporarum leniter dense serrulata. Cellulae steriles in turmis parvis irregularibus vel raro in catervis brevibus, cellulae singulae hemigloboideae, subcuneiformes vel irregulares cum latere uno vel lateribus nonnullis depressis, raro ellipsoidales, 7-16 µm longae, hyalinae; pariete cca. 0,5 µm crasso, levi.

Sori (Fig. 23) in all spikelets of an inflorescence, ovoid or ellipsoidal, 1.5-2 mm long, at first covered by a pale brown peridium which ruptures irregularly disclosing the dark brown, powdery mass of spores intermixed with sterile cells, surrounding a stout, central, narrowing columella often with 1-2 short, thorn-like, apical branches. **Spores** (Figs. 21, 22) when mature single, globose, subglobose, ovoid or broadly ellipsoidal, not subpolyangular, varying in size, 8-12 × 9-14.5(-16) µm, medium dark yellowish-brown; wall even, 0.5-1 µm thick, finely, rather densely echinulate, spore profile finely, densely serrulate. **Sterile cells** (Fig. 21) in small, irregular groups or rarely in short chains, single cells hemigloboid, subcuneiform or irregular, with one or several flattened sides, rarely ellipsoidal, 7-16 µm long, hyaline; wall c. 0.5 µm thick, smooth. *S. myanmarensis* differs from *S. ischaemi* (L. Ling) Vánky (type on *Ischaemum rugosum* Salisb., India), in which the sori are 4-6 mm long, furthermore loose spore balls are present, and the 9-13 µm long spores are often subpolyhedral. *S. myanmarensis* differs also from *S. tonglinense* (Tracy & Earle) Rifai (type on *I. ciliare* Retz, = *I. indicum* (Houtt.) Merrill, Singapore), in which the spores are 9-12 µm long, and more pronouncedly echinulate.

Key to the *Sporisorium* species of *Ischaemum*

1. Sori in the spikelets 2
 - Sori in the whole inflorescence 8
2. Sori in some spikelets of an inflorescence *S. semisagittatum*
 - Sori in all spikelets of an inflorescence. 3
3. Spore balls ephemeral. 4
 - Spore balls not ephemeral, separate by pressure. *S. furcatum*
4. Spores 8-10 µm long. *S. hainanae*
 - Spores larger. 5
5. Spores 10.5-15 µm long; wall unevenly thick *S. ischaemicola*
 - Spores smaller or larger; spore wall evenly thick 6
6. Spores prominently echinulate, profile serrate *S. tonglinense*
 - Spores finely echinulate, profile finely serrulate 7
7. Sori 4-6 mm long; spores mostly subpolyhedral *S. ischaemi*
 - Sori 1.5-2 mm long; spores globose to broadly ellipsoidal *S. myanmarensis*

- 8(1). Spores 5-7 μm long, flattened on one side, apparently smooth to very finely punctate *S. ischaemi-anthephoroidis*
 – Spores larger, not flattened on one side, evidently ornamented. 9
 9. Columellae several, filiform; spores dimorphic; no sterile cells .. *S. ischaemianum*
 – Columella one; spores not dimorphic; sterile cells present. 10
 10. Columella long, flagelliform; spores 12-19 μm long *S. flagellatum*
 – Columella stout, with bifurcate tip; spores 11-13.5 μm long .. *S. ischaemi-rugosi*



Fig. 23. Sori of *Sporisorium myanmarensis* in the spikelets of *Ischaemum indicum* (type). Habit, and enlarged a sorus. Bars = 1 cm for habit, and 2 mm for detail drawing.

Fig. 24. Sori of *Entyloma heterothecae* on a leaf of *Heterothecha subaxillaris* (type). Bar = 1 cm.

A new species of *Entyloma* on *Heterotheca* (Asteraceae)

The large species complex of *Entyloma compositarum* Farl., on *Asteraceae*, was subsequently split into numerous species, based partly on morphological characters but mostly on host plant taxonomy (host genera) and recently also on molecular biological results. The smut on *Heterotheca* is described as:

***Entyloma heterothecae* Vánky, sp. nov.**

MYCOBANK510360.

Typus in matrice *Heterotheca subaxillaris* (Lam.) Britton & Rusby, USA, Kansas, Rooks Co., Alcona, near Stockton, 21.VIII.1895, E. Bartholomew, holotypus BPI 175026, isotypi BPI 175025, 175027, 175028 (ut *Entyloma compositarum*).

Sori in foliis maculas parvas, polyangulares, diametro 0,5-1 mm, vel propter confluentiam earum majores, pallide brunneas, in statu juniore in latere abaxiale albas formantes. Sporae globosae, subglobosae, ovoideae vel parum irregulares, 8-11 × 9-12(-13) µm, subhyalinae usque pallide flave suffusae; pariete aequali, cca. 0,5 µm crasso, levi. Anamorpha praesens.

Sori (Fig. 24.) on leaves forming small, polyangular spots, 0.5-1 mm in diam., or larger by confluence, pale brown, when young white on the abaxial side. *Spores* (Fig. 25) globose, subglobose, ovoid or slightly irregular, 8-11 × 9-12(-13) µm, subhyaline to pale yellow tinted; wall even, c. 0.5 µm thick, smooth. *Anamorph* present.

On *Asteraceae*: *Heterotheca subaxillaris* (Lam.) Britton & Rusby (*Inula subaxillaris* Lam.; *Heterotheca lamarckii* Cass.). Known only from the type locality.

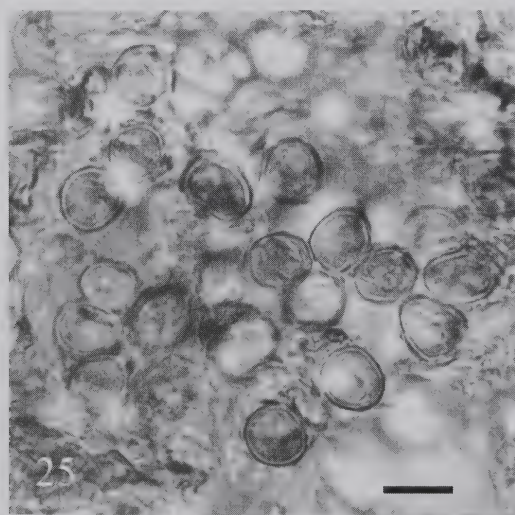


Fig. 25. Spores of *Entyloma heterothecae* on *Heterotheca subaxillaris* in LM (type).

Bar = 10 µm.

NEW NAMES

***Macalpinomyces patilorum* Vánky & A.R. Patil, nom. nov.**

MYCOBANK510366

Replacing *Macalpinomyces digitariae* A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol.34:838, 2004 (later homonym, non *M. digitariae* Vánky & R.G. Shivas, 2003). — Type on *Digitaria ternata*, India, Maharashtra State, Kolhapur, Shivaji University Campus, 21.IX.1995, M.S. Patil, HClO 42826; isotypes Kolhapur W.I.F. 1504, HUV 21251.

Sori in some ovaries of an inflorescence, inconspicuous, 3–4 mm long, more or less hidden by the floral envelopes, at first covered by a thick, dark brown peridium which ruptures irregularly disclosing the dark brown, semiagglutinated to granular-powdery mass of (pseudo) spore balls and spores intermixed with sterile cells. *Spore balls* extremely variable in shape and size, composed of tens or hundreds of spores which separate easily by pressure. *Spores* subglobose, ovoid, ellipsoidal to usually rounded subpolyhedrally irregular, $6.5\text{--}9 \times 7\text{--}12\text{ }\mu\text{m}$, yellowish- to reddish-brown; wall even, c. $0.5\text{ }\mu\text{m}$ thick, from apparently smooth to finely, rather densely verrucose or verrucose-echinulate, spore profile smooth to finely wavy. *Sterile cells* single, globose or subglobose, $10\text{--}28\text{ }\mu\text{m}$ long, subhyaline to pale yellowish-brown; wall even, c. $0.5\text{ }\mu\text{m}$ thick, smooth.

On *Poaceae*: *Digitaria ternata* Stapf, S. Asia (India). Known only from the type collection.

Macalpinomyces patilorum differs from *M. digitariae* Vánky & R.G. Shivas (type on *Digitaria gibbosa* (R. Br.) P. Beauv., Australia), especially in the sterile cells. These in the Australian species are in irregular groups or single, measuring $7\text{--}13 \times 8\text{--}14\text{ }\mu\text{m}$, are pale yellowish-brown, with a $1\text{--}1.5\text{--}(2)\text{ }\mu\text{m}$ thick wall.

Etymology: This species is named in honour of the two eminent mycologists from Kolhapur (M.S., India), Prof. M.S. Patil, and the late Prof. T.M. Patil, authors of numerous mycological papers, in which a great number of new taxa of various microfungi have been described, including also this smut fungus.

***Sporisorium muticae* Vánky & A.R. Patil, nom. nov.**

MYCOBANK510365

Replacing *Sorosporium apludae-muticae* A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl.Pathol. 34:839, 2004 (later homonym, non *Sporisorium apludae-muticae* L. Guo, 1999).

— Type on *Apluda mutica*, India, Maharashtra State, Kolhapur, Shivaji University Campus, 13.XII.1985, S.C. Pardeshi, HClO 42840; isotypes Kolhapur W.I.F. 1520, HUV 21256.

Sori destroying the whole racemes, cylindrical, c. $0.5 \times 8\text{--}10\text{ mm}$, partly hidden by the uppermost leaf sheath, first covered by a yellowish-brown peridium which ruptures irregularly disclosing the dark brown, powdery mass of spore balls and spores surrounding a long, simple, narrow columella. *Spore balls* variable in shape and size, usually irregular, $30\text{--}100 \times 50\text{--}160\text{ }\mu\text{m}$, dark reddish-brown to opaque, composed of tens or hundreds of spores which separate easily by pressure. *Spores* dimorphic. Outer spores subglobose, ovoid, ellipsoidal to

irregular, $8\text{--}14.5 \times 11\text{--}16\ \mu\text{m}$, dark reddish-brown; wall uneven, $1\text{--}2\ \mu\text{m}$ thick, finely punctate-verruculose, spore profile smooth. Inner spores irregular, subpolyhedral, elongated, usually with undulate outline, $7\text{--}10.5 \times 8.5\text{--}14.5\ \mu\text{m}$, yellowish-brown; wall even, c. $0.5\ \mu\text{m}$ thick, apparently smooth.

On *Poaceae*: *Apluda mutica* L.; S. Asia (India). Known only from the type collection.

Sporisorium muticae differs from the closely related *S. apludae-muticae* L. Guo especially by larger outer and inner spores. These in *S. apludae-muticae* are $7\text{--}12$, and $5\text{--}10.5\ \mu\text{m}$ long, respectively.

NEW COMBINATIONS

What is *Sorosporium pedicularis*?

A smut fungus on *Pedicularis* was published first by Gutner (1941:182, invalidly, without Latin diagnosis) under the name of *Sorosporium pedicularis* Golovin, later validly by Golovin (1950:11), under the same name. Its generic position is questionable. The genus *Sorosporium* F. Rudolphi was merged with *Thecaphora* Fingerh. (comp. Vánky, 1998). However, the morphology of the spore balls and spores of this smut deviates much from that of *Thecaphora* species, including the colour of the spore masses and spores. Another genus, which can be taken into consideration is *Urocystis*, but sterile cells are lacking in our fungus. There are species of *Urocystis*, in which sterile cells are few or even lacking around some of the spore balls. Unfortunately, DNA isolation and molecular biological analyses were unsuccessful. Based on the dicotyledonous host plant, on the colour of the spores and morphology of the spore balls and spores, I consider that *Sorosporium pedicularis* represents an extreme case of *Urocystis*, in which the sterile cells are lacking.

Urocystis pedicularis (Golovin) Vánky, **comb. nov.**

MYCOBANK510382

Basionym: *Sorosporium pedicularis* Golovin, Sredneaz. Gosud. Univ., N.S., Vyp. 14, Biol. Nauk., Kniga 5:11, 1950. — Type on *Pedicularis* sp., Tadzhikistan, East Pamir, Tschatkyoj, in the valley of the Murgab River, 9.IX.1937, N. Nikiforova (type where?).

Sori in all capsules of an inflorescence, swollen, deformed, filled with blackish-brown, granular-powdery mass of spore balls. *Spore balls* subglobose, ovoid, ellipsoidal, elongated to irregular, $25\text{--}75 \times 35\text{--}90\ \mu\text{m}$, reddish-brown, composed of a few to tens of spores which separate by pressure. *Spores* varying in shape and size, subglobose, ovoid, ellipsoidal, elongated, irregular, subcuneiform, $8\text{--}14.5 \times 10.5\text{--}22\ \mu\text{m}$, reddish-brown; wall even, $0.5\text{--}1\ \mu\text{m}$ thick, apparently smooth, in SEM very finely, low verruculose. *Sterile cells* lacking.

On *Scrophulariaceae*: *Pedicularis sibthorpii* Boiss., *Pedicularis* sp.; Asia (Iran, Tadzhikistan).

Type not seen. Description based on the Iranian specimen (HUV 15331).

Ustilago glabra (A.R. Patil, T.M. Patil & M.S. Patil) Vánky & A.R. Patil, **comb. et stat. nov.** MYCOBANK510436

Based on *Ustilago trichophora* var. *glabra* A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:842, 2004. — Type on *Echinochloa crus-galli*, India, Karnataka State, Mysore, 21.XI.1987, S.R. Yadav, HCIO 43835; isotypes Kolhapur W.I.F. 1581, HUV 21271.

Sori in considerably swollen ovaries, filaments or basal part of inner floral envelopes, forming globoid, ovoid, ellipsoidal or slightly irregular bodies, 1–4 mm long, showing between the spreading outermost floral envelopes, usually several in a group, some of them bearing remnants of the stigma, sterile anthers or floral envelopes, at first covered by a smooth, hairless greyish-brown peridium which ruptures irregularly at maturity, disclosing the brown, first agglutinated, later powdery mass of spores. *Spores* globose, subglobose; ovoid, ellipsoidal, rarely elongated, 6–9 × 7–9.5(–10.5) µm, light yellowish-brown; wall even, c. 0.5 µm thick, provided with sparsely situated low spines, spore profile smooth, in SEM finely verruculose between the warts or spines.

On *Poaceae*: *Echinochloa crus-galli* (L.) P. Beauv.; S. Asia (India). Known only from the type collection.

Ustilago glabra differs from the closely related *U. trichophora*, on several *Echinochloa* species, in sorus and spore morphology. In *U. trichophora* the sori are always hispid, the spores are somewhat larger (6–11 × 7–12 µm), and more densely and coarsely echinulate, causing the spore profile a serrulate aspect.

Study of the type specimens of *Doassansia ranunculina* and *D. putkonenii*, both on *Ranunculus*, revealed that they belong to the genus *Heterodoassansia*, and also that they represent the same species. Liro (1938:215), comparing the two species wrote, that the main difference between them was that the cortical cells of *D. ranunculina* had a smooth wall whereas those of *D. putkonenii* appeared small-punctate. Mature inner cells of the cortex of both species are similarly ornamented.

Heterodoassansia ranunculina (Davis) Vánky, **comb. nov.**

MycoBank510383

Basionym: *Doassansia ranunculina* Davis, Bot. Gaz. (Crawfordsville) 19:416, 1894. — Type on *Ranunculus multifidus*, USA, Wisconsin, Racine, VIII.1894, J.J. Davis; isotypes in Ellis & Ev., N. Amer. figi. no. 3238, HUV 9177!

Doassansia putkonenii Liro, Luonnon Ystävä 24:72, 1920 (as '*Putkoneni*'). — *Heterodoassansia putkonenii* (Liro) Vánky, Mycotaxon 48:28, 1993. — Type on *Ranunculus paucistamineus* (= *R. trichophyllus*), Finland, Åland, Eckerö island, Storby, 22.VII.1919, T. Putkonen, H! (syn. nov.).

Sori on the leaves forming circular or elliptic, indistinct to pale brown spots, 0.5–3(–5) mm in diam., or on the petioles as pustules, with numerous spore balls embedded in the host tissue showing as minute, pale or dark brown, often aggregated dots on both sides of the leaves. *Spore balls* globose, subglobose,

ellipsoidal or irregular, $25\text{--}175 \times 50\text{--}200\ \mu\text{m}$, orange tinted yellowish-brown, composed of a central mass of spores surrounded by a cortex of empty, sterile cells. *Spores* globose, ellipsoidal to subpolyhedrally irregular, $7\text{--}14 \times 9\text{--}15\ \mu\text{m}$, pale yellowish-brown tinted; wall even, c. $0.5\ \mu\text{m}$ thick, smooth. *Cortex* composed of two kinds of cells: an inner, continuous layer of usually radially elongated but also polyhedral or irregular, large, empty cells, $6\text{--}17 \times 10\text{--}24\ \mu\text{m}$, flattened on their contact sides, pale yellowish-brown; wall even, c. $0.5\ \mu\text{m}$ thick, finely to evidently, rather densely punctate to verrucose-echinulate on its inner surface (that toward the empty lumen) due to small or large (up to $0.5\text{--}1.5\ \mu\text{m}$ high) spines or nail-headed warts. A thin, external, often incomplete layer of radially flattened, small to elongated, smooth sterile cells covers the large, ornamented cortical cells. *Spore germination* unknown.

On *Ranunculaceae*: *Ranunculus aquatilis* L., *R. limoselloides* Tourcz., *R. multifidus* Pursh, *R. trichophyllus* Chaix (*R. paucistamineus* Tausch), *R. peltatus* Schrank; Europe (Finland, Germany), N America (USA), S. America (Venezuela).

There are some differences in the size of the spore balls, spores and sterile cells, as well as in the ornamentation of the large, cortical sterile cells between collections on different host plant species, which are considered variations within the same species.

***Sporisorium chrysopogonis-fulvi* (A.R. Patil, T.M. Patil & M.S. Patil) Vánky & A.R. Patil, comb. nov.**

MYCOBANK510405

Basionym: *Sorosporium chrysopogonis-fulvi* A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol.

Pl. Pathol. 34:839, 2004 (as '*chrysopogonis-fulvi*s'). — Type on *Chrysopogon fulvus*, India, Maharashtra State, Kolhapur, Shivaji University Campus, 9.XII.1997, M.S. Patil, HClO 42841; isolates Kolhapur W.I.F. 1521, HUV 21257.

Sori in some spikelets of an inflorescence, both sessile, perfect, and pedicelled, sterile ones, cylindrical, $1\text{--}1.5 \times 6\text{--}10\ \text{mm}$ long, showing between the outermost floral envelopes, at first covered by a greyish- or pale brown peridium which ruptures at maturity from its apex, disclosing the blackish-brown, first agglutinated, later granular powdery mass of spore balls surrounding a long, filiform or band-like central columella. *Spore balls* variable in shape and size, subglobose, ellipsoidal, elongated to usually irregular, $35\text{--}110 \times 40\text{--}170\ \mu\text{m}$, dark reddish-brown to opaque, composed of tens or hundreds of spores which separate by hard pressure. *Spores* dimorphic; outer spores globoid, ellipsoidal to subpolyhedrally irregular, $7\text{--}11 \times 8\text{--}13.5\ \mu\text{m}$, dark reddish-brown; wall $0.5\text{--}1.5\ \mu\text{m}$ thick (including ornamentation), thickest on the free surface where it is provided with rather densely situated, up to $1\ \mu\text{m}$ high cylindrical warts or subacute spines, spore profile smooth to serrate on the free surface; inner spores subglobose, ellipsoidal to usually rounded subpolyhedrally irregular, pale yellowish-brown; wall even, c. $0.5\ \mu\text{m}$ thick, smooth.

On *Poaceae*: *Chrysopogon fulvus* (Spreng.) Choiv. Known only from the type collection.

***Tilletia beckeræ* (Henn.) Vánky, comb. nov.**

MYCOBANK510384

Basionym: *Ustilago beckeræ* Henn., in Wildeman, Ann. Mus. Congo, Sér. 5, Bot. 2:86, 1907. — Type on *Beckera* sp. (= *Snowdenia* sp.), Congo, Leopoldville Prov., Kisantu, V.1906, H. Vanderyst 169, BR.

Sori in some, slightly swollen ovaries of an inflorescence, c. $1 \times 2\text{--}3$ mm, filled with a brown, semiagglutinated to powdery mass of spores and sterile cells. *Spores* globose or subglobose, rarely broadly ellipsoidal, $16\text{--}25 \times 16\text{--}26$ μm , pale to medium dark olivaceous-brown; wall $3\text{--}5$ μm thick, including a thin endospore and the densely situated, long, filiform, nail-headed or subacute spines. These, in surface view appear as dark, small, irregularly polyangular areas, 9–16 per spore diam., in optical median view 40–50 on the equatorial circumference. *Sterile cells* subglobose, ellipsoidal or slightly irregular, varying in size, $12\text{--}24 \times 13.5\text{--}28$ μm , pale olivaceous brown; wall $1.5\text{--}5$ μm thick, smooth. Intermediate forms, with a trace of ornamentation, are present.

On *Poaceae*: *Snowdenia* sp. (*Beckera* sp.); C. Africa (Congo). Known only from the type collection.

***Tilletia sphaerocarpa* (Syd. & P. Syd.) Vánky, comb. nov.**

MYCOBANK510385

Basionym: *Ustilago sphaerocarpa* Syd. & P. Syd., Ann. Mycol. 15:145, 1917. — Type on *Festuca amplissima*, Mexico, Popocatepetl, 8.IX.1908, H. Schenk 371; isotypes BPI 166643!, WSP 34977.

Sori in some ovaries of an inflorescence, oblong, broadly fusiform, c. $1 \times 3\text{--}5$ mm, showing between the spreading floral envelopes, first covered by the pericarp which ruptures disclosing the black, powdery mass of spores intermixed with few sterile cells. *Spores* globose, subglobose, rarely broadly ellipsoidal, $14.5\text{--}18.5 \times 15\text{--}20$ μm , dark yellowish-brown to chocolate-brown; wall even, $2\text{--}3$ μm thick, densely verrucose, spore profile wavy to finely serrulate, warts $0.5\text{--}1$ μm high, in LM with rounded or flattened tip. *Sterile cells* subglobose, ovoid or slightly irregular, $20\text{--}35$ μm long, subhyaline, usually collapsed; wall $1.5\text{--}2.5$ μm thick, smooth or finely punctate.

On *Poaceae*: *Festuca amplissima* Rupr.; N. America (Mexico). Known only from the type locality.

Presence of sterile cells between the spores escaped the observation of earlier mycologists.

Ustilago sleumeri* is a *Tilletia

Petrak (1947:206) described *Ustilago sleumeri* on the leaves of *Alopecurus gerardii* (*Poaceae*) from Andorra. The type of *U. sleumeri* in BPI 195252 is devoid of spores. However, based on the accurate (but incomplete) original description, I have no doubt that *U. sleumeri* is a *Tilletia*.

Of the nearly 160 known species of *Tilletia*, only 11 have sori in the vegetative tissues of the host plants. These are: 1. *T. alopecuri* (Sawada) L. Ling (type on *Alopecurus aequalis*, Taiwan), 2. *T. bolayi* H. Zogg (type on *Bromus erectus*, Switzerland), 3. *T. brachypodii-ramosi* H. Zogg (type on *Brachypodium ramosum* France), 4. *T. earlei* Griffiths (type on *Agropyron occidentale*, USA), 5. *T. flectens* Lagerh. (type on *Deschampsia flexuosa*, Sweden), 6. *T. nigrifaciens* Langdon & Boughton (type on *Phragmites australis*, Australia), 7. *T. olida* (Riess) J. Schröt. (type on *Brachypodium pinnatum*, Germany), 8. *T. sesleriae* Juel (lectotype on *Sesleria caerulea*, Sweden), 9. *T. sterilis* Ule (lectotype on *Koeleria cristata*), 10. *T. tumefaciens* Syd. & P. Syd. (type on *Panicum antidotale*, India), and 11. *T. youngii* G.P. Clinton & Zundel (type on *Alopecurus ramosus*, USA). A comparison of *U. sleumeri* (the description of which is based on the original) with the enumerated *Tilletia* species revealed several similarities but also differences (see the key below).

***Tilletia sleumeri* (Petr.) Vánky, comb. nov.**

MYCOBANK510386

Basionym: *Ustilago sleumeri* Petr., Sydowia 1:206, 1947. — Type on *Alopecurus gerardii*, Andorra, East Pyrenean Mts, between Port d'Embalire and Pic Negre, above the creek Ariège, 2200-2500, VII. H. Sleumer, BPI 195252 (lacking spores).

Sori on the leaves and leaf sheaths as rounded or elongated, up to 1 cm long greyish-green to dark grey spots formed of narrow (250-500 µm wide), parallel, slightly pustular striae between the veins, covered by the epidermis which ruptures longitudinally disclosing the olivaceous-brown, powdery mass of spores. Spores single, globose, ovoid, ellipsoidal to subpolyhedrally irregular, 18-24 × 19-27 µm, pale greyish- or olivaceous-brown; wall 2.5-3.5 µm thick, reticulate, meshes rather regular, penta- or hexagonal, 2-3 µm in diam.

On Poaceae: *Alopecurus gerardii* Vill.; Europe (Andorra). Known only from the type locality.

Key to the species of *Tilletia*, with sori in the vegetative tissues of the host plants

1. Sori as witches' brooms on the stems of *Panicum* *T. tumefaciens*
- Sori not as witches' brooms; not on *Panicum* 2
2. Sori as dark, powdery cover on the surface of the leaves of *Phragmites*
..... *T. nigrifaciens*
- Sori not so; not on *Phragmites* 3
3. Sori as swellings on the stems 4
- Sori as striae on the leaves and leaf sheaths 6
4. Sori in the upper, swollen internodes of sterile shoots of *Agropyron*, *Elymus*
..... *T. earlei*
- Sori as swellings on stems, as striae on leaves and in seeds of *Alopecurus* 5

5. Spores 17-22(-25) μm long, with 2-3 μm high warts which fuse in an irregular or cerebriform pattern *T. alopecuri*
- Spores 21-24(-29) μm long, with 2.5-4 μm high spiny tubercles *T. youngii*
6. On *Brachypodium*; spores reticulate. 7
- Not on *Brachypodium*; spores reticulate or not. 8
7. Muri 0.5-1(-1.5) μm high, in median view truncate *T. olida*
- Muri 1-1.5(-2.5) μm high, in median view pointed. *T. brachypodii-ramosi*
8. Spores 25-36 μm long. On *Sesleria* *T. sesleriae*
- Spores smaller. Not on *Sesleria* 9
9. Spores obscurely reticulate, 8-20 meshes per spore diam. On *Festuca*, *Koeleria*, *Poa* *T. sterilis*
- Spores evidently reticulate, meshes fewer. Not on *Festuca*, *Koeleria*, *Poa* 10
10. Spores 17-24(-27) μm long, mostly cerebriform. On *Bromus* *T. bolayi*
- Spores larger, evidently reticulate. Not on *Bromus*. 11
11. Spores 21-30 μm long, wall 2.5-4 μm thick. On *Deschampsia* *T. flectens*
- Spores 19-27 μm long, wall 2.5-3.5 μm thick. On *Alopecurus* *T. sleumeri*

SYNONYMS

Anthracoida haematostomae is conspecific with *A. nepalensis*

A study of some *Anthracoida* species of *Carex*, subgen. *Carex*, sect. *Aulocystis* (= *Frigidae*), by the author and by M. Piątek (Kraków, Poland), revealed that *A. haematostomae* is identical with, and a synonym of the earlier described *A. nepalensis*:

Anthracoida nepalensis Kakish. & Y. Ono, in Watanabe & Malla, Cryptogams of the Himalayas 1:128, 1988.

Type on *Carex nakaoana*, Nepal, Langtang valley, Kyangjin Langshisa, alt. 3900 m, 3.IX.1986, Y. Ono 86NE-234, TSH-S1025; isotypes KATH, HUV 13603.

Anthracoida haematostomae L. Guo, Fungal Diversity 21:83, 2006. — Type on *Carex haematostoma*, China, Yunnan Prov., Degen, alt. 2700 m, IX.1935, C.W. Wang 70101, HMAS 132709; isotype HUV 20090. (syn. nov. by Vánky & M. Piątek).

Sori in ovaries, globoid to ellipsoidal, 1.5-2 $\times$ 1.5-3.5 mm, at first covered by a thin, greyish fungal peridium, later naked, black, agglutinated with powdery surface. *Spores* small, flattened, in side view elliptic, 9.5-12 μm wide, with hyaline caps on the flat sides, in plane view circular or broadly elliptic, rarely ovoid or slightly irregular, 14.5-18.5 $\times$ 16.5-20(-21) μm , dark reddish-brown; wall even, 1.5-2.5(-3) μm thick, no internal swellings, no protuberances, no light refractive spots, surface sparsely, finely to coarsely verrucose, spore profile wavy to sparsely serrate.

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Aulocystis* = *Frigidae*), *C. haematostoma* Nees, *C. nakaoana* T. Koyama, *C. digyna* (Kük.) Tang & Wang, *C. sempervirens* Vill.; C., S. & E. Asia.

***Cintractia obovoidea* is a *Farysia* sp.**

Cintractia obovoidea Togashi & Y. Maki, Ann. Phytopathol. Soc. Japan 10:139, 1940.

Anthracoidea obovoidea (Togashi & Y. Maki) Kakish., Mem. Inst. Agr. & For. Univ. Tsukuba 1:28, 1982. — Type on *Carex fernaldiana*, Japan, Hizen Prov., Karatsu, 22.V.1937, Y. Maki, BPI 195039.

According to the original description, *sori* in the ovaries, swollen, dark brown, hard, obovoid or subglobose, 1-2 mm in diam., first covered by the glumes, later naked, with powdery surface. *Spores* variable, globose or ellipsoidal, 5-10 × 6-11 µm, dark brown, verruculose.

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Mitratae*), *C. fernaldiana* Lév. & Vaniot; E. Asia (Japan).

The spore measurements given by Togashi & Maki (1940) are too small for an *Anthracoidea* species. Study of the extremely scanty type material in BPI 195039 revealed spores of a *Farysia* species which measure (3-)4-7 × 5-9 µm, are pale olivaceous brown, verruculose.

Doassansia disticha* is a synonym of *D. opaca

Doassansia opaca Setch., Proc. Amer. Acad. Arts 26:15, 1891.

Lectotype on *Sagittaria sagittifolia* L., USA, (designated here) Connecticut, Norwich, 14.VIII.1889, W.A. Setchell, HUV 507; isotypes in Rbh., Fgi. eur. no. 3802, BPI 178488, 178514, 178515, 195046.

Doassansia disticha S. Ito, Trans. Sapporo Nat. Hist. Soc. 14:96, 1935. — Type on *Sagittaria trifolia* var. *typica*, Japan, Honshu, Inaba Prov., Tottori, X.1930, N. Hiratsuka, BPI 178338. (Syn. nov.).

Sori as leaf spots, orbicular, slightly swollen, 2-4 mm in diam., with spore balls as pale brown dots on the abaxial surface. *Spore balls* crowded, globose, ellipsoidal to subtetragonal or cubical by mutual pressure, 90-220 µm long, pale brown, composed of a central mass of spores surrounded by a cortical layer of sterile cells. *Spores* subglobose, ovoid to usually rounded subpolyhedrally irregular, 8-12 × 9.5-14.5 µm, pale yellow tinted; wall c. 0.5 µm thick, smooth. Between the spores there are some sterile cells about the shape and size of the spores. *Cortical cells* variable in shape and size, usually radially elongated, cubical or irregular, 8-20 × 9.5-30 µm, pale yellowish-brown tinted; wall c. 0.5-1 µm thick, smooth.

On *Alismataceae*: *Sagittaria trifolia* var. *typica* Makino; E. Asia (Japan), N. America (Canada, USA).

Doassansiopsis horiana* is considered to be a synonym of *D. deformans

Setchell (1891:17) described *Doassansia deformans*, causing conspicuous swellings and distortions on *Sagittaria variabilis* in Canada. Dietel placed the fungus into the genus *Doassansiopsis*. Hennings (1906:157), described a similar fungus on *Sagittaria sagittifolia* from Japan, under the name of *Doassansia horiana*, which was placed into the genus *Doassansiopsis* by C.I.

Shen (= C.I. Chen). A comparison of the types could not reveal any essential difference between the two collections excepting somewhat larger spore balls in *D. horiana*, and somewhat larger sterile cells in *D. deformans*, which are considered variations within the same species. Consequently, they are considered synonyms as:

Doassansiosis deformans (Setch.) Dietel, in Engler, Die Natürl. Pflanzenfam. 1(1)**:21, 1897.

Doassansia deformans Setch., Proc. Amer. Acad. Arts 26:17, 1891. — Lectotype on *Sagittaria variabilis* (= *S. sagittifolia*), (design. by Vánky, 2002:48) Canada, London, IX.1890, J. Dearness, HUV 475; isoelectotypes in Ellis & Ev., N. Amer. fgi., Ser. 2, no. 2705 (as *Doassansia deformans*).

Doassansia horiana Henn., Bot. Jahrb. Syst. 37:157, 1906. — *Doassansiosis horiana* (Henn.) C.I. Chen (as 'C.I. Shen'), Sinensia 4:319, 1934. — Type on *Sagittaria sagittifolia*, Japan, Tokyo, Nashigahara, VIII.1904, S. Hori 34, SAPA; isotypes BPI 178362, 195044, HUV 16633. (syn. nov.).

Sori in leaves, petioles, stems and inflorescence as brown, bullate pustules or swellings, often causing conspicuous distortions, from a few mm to 7-8 cm long, filled with spore balls embedded in the host tissue. *Spore balls* globose, subglobose, ovoid, elongated or irregular, 70-150(-220) × 90-180(-250) µm, pale yellowish-brown, composed of a central mass of sterile, parenchymatous, empty cells surrounded by a layer of spores and a thin cortical layer of sterile cells. *Spores* globoid, ovoid, radially elongated, usually polyhedrally irregular, 7-11 × 9-17(-20) µm, pale yellowish-brown, contents homogenous; wall c. 0.5 µm thick, smooth. *Sterile cells* variable in shape and size, rounded or elongated, polyhedrally irregular, 4-17 × 6-30 µm, empty, subhyaline to pale yellow tinted; wall c. 0.5 µm thick, smooth. *Cortical sterile cells* variable in shape and size, small, usually tangentially more or less flattened, irregularly polyhedral, 5.5-15 µm long, pale yellowish-brown, empty; wall c. 0.5 µm thick, smooth. *Spore germination* of *Tilletia*-type (Setchell, 1892).

On *Alismataceae*: *Sagittaria lancifolia* L., *S. sagittifolia* L. (*S. latifolia* Willd., *S. variabilis* Engelm.), *S. trifolia* L., *S. trifolia* var. *sinensis* (Sims.) Makino; E Asia (China, Japan), N & C America (Canada, USA, Honduras), W Indies (Cuba).

Entyloma blumeae* is a synonym of *E. thirumalacharii

The first described smut fungus on *Blumea* was *Entyloma globigena* Thirum. & Safeeulla (Thirumalachar & Safeeulla 1951:443), type on *Blumea* sp., India, Mysore, Coorg, 15.X.1950, K.M. Safeeulla. According to the original description, the spores are subglobose to angular, 9-18 µm, pale cinnamon-yellow, wall 1.5-2(-4) µm thick. Spore germination results in holobasidia bearing terminal cluster of 4-6 basidiospores which do not conjugate in situ.

Almost concurrently two additional new species of *Entyloma* on *Blumea* have been published: *E. thirumalacharii* Pavgi & R.A. Singh (Pavgi & Singh

1967:942), type on *Blumea oxydonta* DC., India, Uttar Pradesh, Varanasi, 8.IX.1964, V.P. Tewari & R.A. Singh, HClO 29879; isotype HUV 15482!, and *E. blumeae* B.V. Patil & Thirum. (Patil & Thirumalachar 1968:49), type on *Blumea malcolmii* Hook. f., India, Maharashtra State, Nasik, Ratnagiri, 2.I.1961, B.V. Patil. Both are characterised by larger spores ($12-20 \times 14-24 \mu\text{m}$), and thicker spore wall ($1.5-6 \mu\text{m}$). Spore germination results in holobasidia with an apical whorl of 4-8 basidiospores which fuse in pairs. These two names obviously represent the same species. *E. thirumalacharii* having priority, while *E. blumeae* is considered to be its synonym. (syn. nov.).

Entyloma wisconsinense* is considered to be *E. saccardianum

Ciferri (1928:40) described *Entyloma wisconsinense* Cif., type on *Senecio aureus* L., USA, Wisconsin, Wild Rose, 2.VII.1918, J.J. Davis, PAD! For the spore measurements, Ciferri gave $7.5-8.5(-9) \mu\text{m}$. By study of the type specimen I obtained $9-12 \times 9.5-14.5 \mu\text{m}$, rather similar to those of *E. saccardianum* Scalia ex Cif. (Ciferri 1924:50), type on *Senecio leucanthemifolius* Poirlet, Italy, Sicily, Catania Prov., near Ognina, II.1901, Criconi, PAD! Consequently, I consider *E. wisconsinense* to be a synonym of *E. saccardianum*. (syn. nov.).

Melanotaenium brachiariae* var. *minutum* is *Eballistra brachiariae

Melanotaenium brachiariae var. *minutum* A.R. Patil, T.M. Patil & M.S. Patil, J. Mycol. Pl. Pathol. 34:841, 2004 (as '*minuta*').

Type on *Brachiaria distachya* (L.) Stapf, India, Maharashtra State, Kolhapur, Shivaji University Campus, 7.II.1996, M.S. Patil, HClO 42797; isotypes Kolhapur W.I.F. 1510, HUV 21250.

Study of the type specimen of *M. brachiariae* var. *minutum* and a comparison of it with the type of *M. brachiariae* (= *Eballistra brachiariae* (Viégas) R. Bauer et al.), type on *Brachiaria plantaginea*, Brazil, could not reveal any essential difference. Hence they are considered to be synonyms.

Mycosyrinx osmundae* var. *osmundae-cinnamomeae* is considered a synonym of *Exoteliospora osmundae

One of the very few smut fungi parasitising non-flowering plants was described as *Ustilago osmundae* (Peck 1881:276), on the royal fern, *Osmunda regalis*, in the USA. Its position amongst the fungi was for a long time obscure. A variety of it was described also by Peck (1912:43) on *Osmunda cinnamomea*, in the USA, because "It differs from the typical form in the paler brown colour of the spore mass and the even surface of the spores". However, there are all intermediate forms in both colour of the spore masses and the ornamentation of the spores, from smooth to densely, prominently verrucose. The warts of the spores are loose, easily detaching of the spore surface. Therefore, it is practical, to treat

both as one species:

Exoteliospora osmundae (Peck) R. Bauer, Oberw. & Vánky, *Mycologia* 91:675, 1999.

Ustilago osmundae Peck, Bot. Gaz. (Crawfordsville) 6:276, 1881. — *Mycosyrinx osmundae* (Peck) Peck, New York State Mus. Bull. 157:43, 1912. — Type on *Osmunda regalis*, USA, Vermont State, 27.VII.1880, C.G. Pringle 1541, NY.

Mycosyrinx osmundae var. *osmundae-cinnamomeae* Peck, New York State Mus. Bull. 157:43, 1912 (as '*Mycosyrinx osmundae cinnamomeae*') — Type on *Osmunda cinnamomea*, USA, Washington Co., Cambridge, 17.VI.1911, S.H. Burnham, NY (syn. nov.).

For its description and illustration see Bauer et al. (1999) or Vánky (2002:60-61).

On *Osmundaceae* (Pteridophyta): *Osmunda cinnamomea* L., *O. regalis* L., *O. regalis* var. *spectabilis* (Willd.) A. Gray; N. America (Canada, USA).

Sporisorium arundinellae-nepalensis* is *S. consanguineum

Ling (1951a:106) described *Sorosporium concelatum* on "*Arundinella nepalensis* Trin." from Australia. The place of this fungus is in the genus *Sporisorium*. Because the name *Sporisorium concelatum* (Zundel) M. Piepenbr. is already used for a smut of *Ischaemum latifolium*, a new name, *Sporisorium arundinellae-nepalensis* Vánky (2004:91) was given for it. Dr. Roger G. Shivas called my attention, that the diseased plants are not *Arundinella nepalensis* but a species of *Aristida*, as it was stated in the herbarium DAR by J.W. Vickery, and its smut is *Sporisorium consanguineum* (Ellis & Everh.) Vánky, type on *Aristida rusbyi* Scribn., USA. (syn. nov. by R.G. Shivas & K. Vánky).

Sporisorium themedae-triandrae* is *S. exsertum

Sporisorium themedae-triandrae A.R. Patil et al. (Patil et al. 2004a), was described on *Themeda triandra* Forssk., from India, Maharashtra State, Kolhapur, Shivaji University Campus, 12.I.1996, M.S. Patil, HClO 42865! Study of the type specimen revealed that it is identical with, and a synonym of *Sporisorium exsertum* (McAlpine) L. Guo, type on *Anthistiria ciliata* L. f. (= *Themeda quadrivalvis* (L.) Kuntze), Australia (syn. nov.). The fungus is known on several *Themeda* species from Africa (South Africa, Zimbabwe), S. & E. Asia (China, India, Pakistan, Sri Lanka) and Australasia (Australia, Papua New Guinea).

In the original description of *S. themedae-triandrae* the spores are given as '11-15 × 18.5 µm, with 2-3 µm thick wall. For the spores of the type specimen I obtained 6.5-9 × 7-9.5 µm, with c. 0.5 µm thick wall. I have no explanation for the discrepancy between the description and the spore measurements of the type of *S. themedae-triandrae* found by me. The fungus fits well in all respects with *S. exsertum* (For further synonymy and detailed description of *S. exsertum* see Vánky, 1994:161).

Thecaphora viciae-amoenae* is considered to be *T. viciae

Bubák (1912:38) described *Thecaphora viciae* on *Vicia trifida* from the USA. The smut was found successively in the seeds of several *Vicia* species in Canada, USA and Siberia (comp. Zundel, 1953:124). Harada (1983:300) described *Thecaphora viciae-amoenae* on *Vicia amoena* from Japan, based on a larger number of spores in a ball than in *T. viciae*, and also on the presence of well-developed ridges ("wall-like structures") between the spores on the surface of the balls. Study of several specimens on various *Vicia* species revealed a variation and transition of the mentioned characters, which do not allow a clear delimitation. Therefore, I consider it is better to treat these two names as representing one species:

***Thecaphora viciae* Bubák, Arch. Přír. Výzk. Čech. 15:38, 1912.**

Lectotype on *Vicia trifida* D. Dietr. (= *V. americana* Muhl.), USA, (design. by Vánky, 1985:124) Utah, Salt Lake Co, City Creek Cañon, Wasatch Mts., 7.VII.1904, A.O. Garrett, HUV 2130!; isoelectotypes in Sydow, Ust. no. 368 (as *Thecaphora deformans*), and in Seymour & Earle, Econ. fgi., Suppl. C., no. 123 (as *T. deformans*), HUV 9711!

Thecaphora viciae-amoenae Y. Harada, Trans. Mycol. Soc. Japan 24:300, 1983. — Type on *Vicia amoena*, Japan, Hokkaido, Saru-gun, Biratori-cho, Nina, at the Sarugawa river, 12.IX.1981, Y. Harada 12428; isotype HUV 11580! (syn. nov.).

Sori in seeds. Pods not or only slightly deformed. Spore mass granular-powdery, reddish-brown. *Spore balls* muriform, globose, ovoid to irregularly elongated, 30-65 × 40-80(-95) µm, yellowish- to reddish-brown, composed of (10-)15-50 (or more?), rather firmly united spores. *Spores* varying in shape and size, in surface view rounded, subpolygonally irregular or elongated, 6-14 × 10-22 µm, in median view 8-20 µm long; wall on the contact surfaces smooth, c. 0.8 µm thick, on the free surface with moderately densely situated, irregular warts, up to 2.5 µm long. Warts may be absent in the centre of the ornamented area in a few spores. On the surface of the balls, a more or less well-developed ridge between the spores may be present in some or in numerous spore balls of a specimen originating from different host plant species.

On *Fabaceae*: *Vicia americana* Muhl. (*V. trifida* D. Dietr.), *V. amoena* Fisch., *V. caroliniana* Walt., *V. cracca* L., *V. oregona* Nutt., *Vicia* sp.; E. Asia (China, Japan, Russia), N. America (Canada, USA).

Tuburcinia secalis* is *Urocystis occulta

Uljanishchev (Steblevaja golovnya pshenitsy:5, 1939) published (invalidly, no Latin diagnosis) *Tuburcinia secalis* Uljan., on *Secale cereale* L. from Azerbajdzhan, VII.1935, isotype HUV 12350. It is identical with *Urocystis occulta* (Wallr.) Rabenh. ex Fuckel, type on *Secale cereale* L. (syn. nov.).

For further synonyms, description, literature and illustrations see Vánky, 1994:299 & 330.

Urocystis colchici-lutei* is a synonym of *U. colchici

Zundel (1944:411) described *Urocystis colchici-lutei* with the remarks that “it differs from *Urocystis colchici* by the smaller sorus, brighter coloured spore-balls and more spores per spore-ball.” Zundel gives spore balls with 1-3(-4) spores. Checking the type specimen I found the following number of spores per spore balls: 1 = 61%, 2 = 28.5 %, 3 = 8 %, 4 = 2.5%. For *Urocystis colchici*, on *Colchicum autumnale*, I found the following values: 1 = 73.5%, 2 = 21.5 %, 3 = 4 %, 4 = 1%. Actually, Mundkur & Thirumalachar (1952:72) considered *U. colchici-lutei* a synonym of *U. colchici*, which is also my opinion.

***Urocystis colchici* (Schltdl.) Rabenh., Fgi. eur. no. 396, 1861.**

Lectotype on *Colchicum autumnale* L., Germany, (design. by Braun, 1979:410) Hassia, near Witzenhausen, V. 1822, J.A.C. Roeper, HAL.

Urocystis colchici-lutei Zundel, Mycologia 36:411, 1944. — Type on *Colchicum luteum*, India, Abbottabad, alt. 4200 ft., 15.-18.IV.1935, R.R. Stewart, Gordon College Herbarium, Plants of Hazara N.W.F.P., Northwest Himalaya no. 14616, BPI 181997! Syn. by Mundkur & Thirumalachar (1952:72, confirmed).

For further synonyms, literature and illustrations see Vánky, 1994:289, 314, 316.

On *Liliaceae*: *Colchicum arenarium* Waldst. & Kit., *C. autumnale* L., *C. biebersteinii* Rouy, *C. bivonae* Guss. (*C. latifolium* Sibth. & Sm.), *C. bornmuelleri* Freyn. (cult.), *C. luteum* Baker, *C. neapolitanum* (Ten.) Ten. (cult.) (*C. orientale* Frivald. ex Kunth), *C. persicum* Baker, *C. procurrens* Baker (*Merendera sobolifera* Hort. ex Baker), *C. triphyllum* G. Kunze (incl. *C. biebersteinii* Rouy), *C. turcicum* Janca, *Merendera trigyna* (Adam) Woronow (*Bulbocodium trigynum* Adam); Europe, Asia, N. America.

Urocystis hispanica* is *U. tritici

In the literature, *Urocystis* on *Aegilops* (*Poaceae*) appears either as *U. tritici* or *U. hispanica*. A comparison of the type of *U. hispanica* on *Aegilops* with several specimens of *U. tritici* on *Triticum* could not reveal any essential difference in the sorus, spore ball, spore and sterile cell morphology. Therefore, I consider them synonyms.

***Urocystis tritici* Körn., Hedwigia 16:33, 1877.**

Type on *Triticum vulgare*, New Holland [= Australia], coll. R. Schomburgk.

Tuburcinia hispanica Syd., Ann. Mycol. 22:290, 1924. — *Urocystis hispanica* (Syd.) Zundel, Ustil. World:320, 1953. — Type on *Aegilops ovata*, Spain, Madrid, Cerro-Negro, 8.V.1921, Dr. Cogolludo & G. Hernk, MA 2981! (syn. nov.).

Sori in leaves, leaf sheaths and stems as long striae, initially lead-coloured, covered by the epidermis which ruptures longitudinally to expose the blackish-brown, powdery mass of spore balls. *Spore balls* subglobose, ovoid, ellipsoidal to elongated, 16-30 × 20-40 µm, composed of 1-3(-5) spores completely invested by a layer of sterile cells. *Spores* globose, hemiglobose, ovoid, elongate or slightly irregular, 10-15 × 12-18(-22) µm, yellowish- to reddish-brown, smooth. *Sterile*

cells subglobose to ovoid, $5-8 \times 6-13 \mu\text{m}$, light yellowish-brown; wall c. $1 \mu\text{m}$ thick, smooth. *Spore germination* (McAlpine, 1910:199, Pl. LI, figs. 191-192; Noble, 1923; M.A. Griffiths, 1924:430, Pl. 2, figs. B-I): On the tip of an aseptate basidium (1-)2-4(-6) cylindrical basidiospores are produced measuring $3-5 \times 12-30 \mu\text{m}$. Basidiospores germinate giving rise to slender infection hyphae and/or secondary sporidia.

On *Poaceae*: *Aegilops lorenti* Hochst. (*A. biuncialis* Vis.), *A. ovata* L., *Triticum aestivum* L. (*T. vulgare* Vill.), *T. dicoccum* Schrank, *T. durum* Desf., *T. turgidum* L.; cosmopolitan, but restricted to warm areas.

Ustilago dactylidis* is *Tranzscheliella hypodytes

Maire (1917:136) described *Ustilago dactylidis* Maire on the culms of *Dactylis glomerata* subsp. *hispanica* (Roth) Nyman, Algeria, near Alger, Pointe Pescade, sea coast, VIII.1916, R. Maire; isotype in BPI 194445!

According to Maire, *Ustilago dactylidis* differs from *U. hypodytes* (= *Tranzscheliella hypodytes* (Schltdl.) Vánky & McKenzie), type on *Leymus arenarius*, in very finely verruculose spores, whereas these in *U. hypodytes* are smooth. However, SEM pictures of both type specimens show a similar, finely verruculose spore surface. Other characters of *U. dactylidis* are also identical with the lectotype of *Tranzscheliella hypodytes*, hence they are considered synonyms. (syn. nov.).

The identity of the host plant of *U. dactylidis* could not be verified. A healthy plant is lacking.

Ustilago echinocloae* is a synonym of *Sporisorium diplosporum

The sori, spores and sterile cells of *Ustilago echinocloae* L. Guo & Y.C. Wang (Vánky & Guo 1987:232; type on *Echinocloa crus-galli*, China, Yunnan Prov., Reg. Xishuangbanna, 60 km W of Jinghong, near Menghai, alt. 1250 m, 25.IX.1985, L. Guo, K. Vánky & Q.-X. Wu, HMAS 50023, isotype HUV 11613!) are in all respects similar to those of *Sporisorium diplosporum* (Ellis & Everh.) Vánky (1999:141; type on *Panicum sanguinale*, USA, Mississippi, Holly Springs, IX.1890, S.M. Tracy 1551). Therefore they are considered to be synonyms. (syn. nov.).

Ustilago kenjiana* is identical with *U. bulgarica

Bubák (1910:53) described *Ustilago bulgarica* in the spikelets of cultivated *Sorghum bicolor* from Bulgaria. Ito (1935:87) described a similar smut, on the same host plant, from Japan, under the name of *Ustilago kenjiana*. In his description, Ito wrote that "This species is closely related to *U. bulgarica*, but it differs in the smaller size of spores as well as in powdery nature of sori.". Agglutinated or powdery mass of spores of *Ustilago* species depends on the maturity of the sori. A comparison of the morphology of the sori as well as

the spores, including SEM pictures, could not reveal any essential difference between these two species, hence they are considered to be synonyms.

Ustilago bulgarica Bubák, Z. Landw. Versuchswes. Oesterr. 1910:53, 1910.

Type on *Sorghum vulgare* (= *S. bicolor*), Bulgaria, Sadovo, near Philippopolis (= Plovdiv), 8.IX.1907, F. Bubák; isotypes in Sydow, Ust. no. 386 (as *Ustilago sorghi* on *Sorghum scoparium*), HUV 3318!; Vgr., Micr. rar. sel. no. 1319 (as *Sphacelotheca sorghi* on *Sorghum scoparium*), HUV 2015!

Ustilago kenjiana S. Ito, Trans. Sapporo Nat. Hist. Soc. 14:87, 1935. — Type on *Andropogon sorghum* Brot. (= *Sorghum bicolor*), Manchuria, Koshurei, 10.IX.1916, K. Miyabe. (syn. nov.).

Sori in all spikelets of an inflorescence replacing the inner floral organs, exceeding the glumes, ovoid or horn-like, with irregularly bullate and furrowed surface, multilocular in structure, 2-3 × 3-5 mm, at first covered by a thin, greyish-brown peridium which ruptures irregularly revealing the dark brown, semiagglutinated to powdery mass of spores and few groups of sterile cells. No columella. *Spores* globose, subglobose or broadly ellipsoidal, laterally flattened, 4-5.5 µm wide, 5.5-7 × 5.5-8 µm, yellowish-brown; wall even, c. 0.5 µm thick, finely, moderately densely punctate-echinulate. *Sterile cells* in irregular groups, single cells subglobose, ovoid, ellipsoidal or irregular, larger than the spores, 10-17.5 µm long, subhyaline; wall thin, c. 0.5 µm thick, smooth.

On *Poaceae*: *Sorghum bicolor* (L.) Moench (*S. vulgare* Pers.; *Andropogon sorghum* Brot.); Europe (Bulgaria), E. Asia (China, Japan).

Ustilago bulgarica is close to *Sporisorium sorghi*, from which it differs especially by the irregular, multilocular sori, covered by a thin peridium, by lack of a columella and by the large size of sterile cells.

Ustilago trachyniae* is considered to be *U. bromivora

Uljanishchev (1948:491) described *Ustilago trachyniae*, type on *Trachynia beludshistanica* Karjagin, Beludshia Britannica [Baluchistan, Pakistan], near Mand, 8.IV.1943, V.I. Uljanishchev (type most probably lost by fire).

Trachynia is a synonym of *Brachypodium*. Neither Uljanishchev (1968:35), nor Karatygin & Azbukina (1989) mentioned *U. trachyniae*. However, the smut of *Trachynia* was considered by these authors to be *U. brachypodii-distachyi* Maire, and *U. bullata* Berk. respectively. At present, the floral smut of *Brachypodium* (*Trachynia*) is recognised as *Ustilago bromivora* (comp. Vánky, 2001:301). Consequently, *U. trachyniae* Uljan. is a synonym of *U. bromivora* (Tul. & C. Tul.) A.A. Fisch. Waldh. (type on *Bromus secalinus* L.). (syn. nov.).

The smut fungus of *Andropogon pumilus* (*Poaceae*)

Gandhe (1978:92), in his typewritten Ph.D. thesis, described (invalidly) a smut fungus on *Andropogon pumilus* Roxb. from Pune (India), under the name *Sorosporium punensis* Gandhe. Patil et al. (2004a:787) published *Sporisorium*

punense A.R. Patil et al. sp. nov. (as '*punensis*'), collected by S.D. Patil, on *A. pumilus* in Pune, 1960. Revising the smut fungi of *Andropogon* (Vánky, 2006b:1-29), not knowing about the paper of Patil et al. (2004a), I described *Sporisorium andropogonis-pumili* sp. nov. on *A. pumilus*, collected by me in Pune, 1992. It seemed very probable that the published names represent the same species. However, between the descriptions, and especially between the illustrations published by Patil et al. (2004a) and Vánky (2006b), there are marked differences. The drawings of an infected host plant and some sori by Patil et al. (2004a:784, Figs. 50-53) do not represent *A. pumilus*. It seems more probable to be a *Chrysopogon* species. The study of a fragment of the holotype, deposited in HClO 4286, confirmed this suspicion. The smut fungus is also different from *Sporisorium andropogonis-pumili*. The scanty type specimen in loan (a fragment of a sorus and some healthy spikelets) did not allow to identify the smut with any of the known smut fungi on *Chrysopogon*. It may represent a new smut on a wrongly identified host plant. *Sporisorium andropogonis-pumili* Vánky remains the valid name of the smut fungus of *Andropogon pumilus*.

The host range of *Sporisorium panicicola* and *S. hodsonii*

Sporisorium panicicola Vánky (type on *Panicum coloratum* L., Island of Réunion), and *S. hodsonii* (Zundel) Vánky (type on *Panicum* sp., South Africa), are two closely related species. *S. hodsonii* differs from *S. panicicola* in the varying thickness of the spore wall, resulting in darker and paler coloured areas of the spores, and the more finely ornamented spores than in *S. panicicola*.

In BPI there is a great number of North American smut fungi on *Panicum* spp. under various names. Revision of some of them resulted in the conclusion that many of them belong to *Sporisorium hodsonii* rather than to *S. panicicola*, including the two paratypes of *S. panicicola* on *Panicum dichotomiflorum*. It seems, that the sole known host plant of *S. panicicola* is *Panicum coloratum*, whereas *S. hodsonii* occur on *Panicum agrostoides* Spreng., *P. capillare* L., *P. dichotomiflorum* Michx. (*P. proliferum* Lam.), *P. hirticaule* Presl, *P. schinzii* Hack. (*P. laevifolium* Hack.), *P. subalbidum* Kunth (*P. longijubatum* Stapf; *P. proliferum* var. *paludosum* Stapf), *P. vaseyanum* Scribn. ex Beal, *Panicum virgatum* L., *Panicum* sp.

The correct name of *Ustilago tumefaciens* Henn.

Hennings (in Engler, 1895:48) described *Ustilago tumefaciens*, a smut fungus on *Andropogon rufus* (Nees) Kunth (= *Hyparrhenia rufa* (Nees) Stapf), from Tanzania. Zundel (1930:149) transferred the name into *Sorosporium*, as *S. tumefaciens*, which is a later homonym (not *S. tumefaciens* McAlpine, 1910). Ciferri (1933:268), discovering the homonymy, named the fungus *Sorosporium zundelianum*. According to recent concept, the fungus belongs to the genus

Sporisorium. The names *Sporisorium tumefaciens* and *S. zundelianum* are both preoccupied. Therefore, I proposed the new name *Sporisorium leelingianum*. However, because there are several validly published names of this fungus, *S. leelingianum* is a superfluous name. The next valid name of this fungus is *Sorosporium tembuti*. Therefore, the name of this smut and its synonyms should be:

***Sporisorium tembuti* (Henn. & Pole-Evans) Vánky, comb. nov.**

MYCOBANK510387

Based on *Sorosporium tembuti* Henn. & Pole-Evans, in Hennings, Botanische Jahrbücher für Systematik 41:270, 1908b. — Type on *Andropogon ?cymbarius* L. (= misnamed *Hyparrhenia tamba* (Steud.) Stapf; comp. Doidge, 1950:380), South Africa, Transvaal, Weterval Onder, 17.VI.1905, J. Burt Davy, PREM 169; isotype HUV 17991!

Ustilago tumefaciens Henn., in Engler, Pflanzenwelt Ost-Afrikas, etc., C, p. 48, 1895. — *Sorosporium tumefaciens* (Henn.) Zundel, 1930:149, non McAlpine, 1910 (non *Sporisorium tumefaciens* (McAlpine) Vánky, 1983:328). — *Sorosporium zundelianum* Cif., 1933:268, nom. nov. (not *Sporisorium zundelianum* Vánky, 1995b:207) — *Sporisorium leelingianum* Vánky, 2003a:190, nom. nov. superfluum pro *U. tumefaciens*. — Lectotype (designated by Vánky, 2003a:190) on *Andropogon rufus* (Nees) Kunth (= *Hyparrhenia rufa* (Nees) Stapf), Tanzania, Kilimandscharo, Rombo Mku, alt. 1450 m, VI.1893, S. Volkens 397 K! (syn. nov.).

Sorosporium healidii Zundel, Mycologia 22:147, 1930. — Type on *Andropogon cymbarius* L. (= *Hyparrhenia* sp.; comp. Doidge, 1950:379), South Africa, Transvaal, Pretoria, 7.V.1916, I.B. Pole-Evans (PREM 9732; isotype HUV 17997!) (syn. by Ling, 1951a:108, as *Sorosporium tembuti*, confirmed).

Sorosporium clintonii Zundel, Mycologia 22:153, 1930. — Type on *Andropogon cymbarius* L. (= misnamed *Hyparrhenia* cf. *tamba* (Steud.) Stapf, det. L. C. in PREM; comp. also Doidge, 1950:378), South Africa, Pretoria, Waterkloof, 14.IV.1916, I.B. Pole-Evans, PREM 9693; isotype HUV 1652! (syn. by Ling, 1951a:108, confirmed).

Sorosporium proliferatum Zundel, Mycologia 22:150, 1930. — Type on *Andropogon hirtus* L. (= misnamed *Hyparrhenia aucta* (Stapf) Stapf ex Stent; comp. Doidge, 1950:380; and/or *H. tamba* (Steud.) Stapf, teste K. Vánky), South Africa, Transvaal, Waterval Boven, 29.XI.1918, I.B. Pole-Evans, PREM 11336; isotype HUV 18006! (syn. by Ling, 1951a:108, confirmed).

For a description, illustrations, host plant range, distribution and comments see Vánky (2003a:190-192).

ADDENDA

After this manuscript was finished, I obtained from M. Piątek the galley proof of a paper, in which he describes a new species on *Setaria* that could be included in detail only here.

13. *Sporisorium kenyanum* M. Piątek, Polish Bot. J., 51:160, 2006.

Type on on *Setaria pallide-fusca* (= *S. pumila*), Kenya, sine loco, coll. P.J. Greenway, IMI 68621.

Sori in distal parts of sterile shoots, preventing development of inflorescences, cylindrical and twisted, up to 7 cm (or more?) long, partly enclosed by healthy

leaf sheaths. At first, spore balls and spores embedded in the parenchymatous tissues between the veins, later disclosed by rupturing the epidermis and leaving the fascicles of vascular bundles. *Spore balls* subglobose, ellipsoidal, oblong to irregular, $14\text{--}50 \times 16\text{--}80\text{ }\mu\text{m}$, dark yellowish-brown, composed of tens to hundreds of spores, permanent when young, later separating. *Spores* globose, subglobose to slightly subpolyhedrally irregular, $4.5\text{--}5.5(-6.0) \times 5.0\text{--}6.0(-6.5)\text{ }\mu\text{m}$, yellowish to pale brown; wall even, c. $0.5\text{ }\mu\text{m}$ thick, surface in LM finely, moderately densely punctate, spore profile smooth, surface in SEM finely verrucose-echinulate. *Sterile cells* absent.

On *Setaria pumila* (Poir.) Roem. & Schult. (*S. pallide-fusca* (Schumach.) Stapf & C.E. Hubb. ex Moss); Africa (Kenya). Known only from the type collection..

An additional new *Tilletia* species was recently collected in India which is described as:

19 *Tilletia setariae-pumilae* Vánky & N.D. Sharma, sp. nov.

MYCOBANK510406.

Typus in matrice *Setaria pumila* (Poir.) Roem. & Schult., India, Madhya Pradesh, Mandla, Kanha National Park border, $22^{\circ}07' \text{N}$, $80^{\circ}26' \text{E}$, alt. cca. 700 m.s.m., 8.X.2006, leg. N.D. Sharma. Holotypus in Herbario Ustil. Vánky, HUV 21399!, isotypus in HClO.

Sori in ovariis nonnullis eiusdem inflorescentiae, globoidei, ovoidei vel ellipsoidales, 1,5-2 x 2-4 mm, saepe cum parte basali subacuta, inter involucra basalia distantia floralia conspicui, peridio crasso atrobrunneo cooperti, quo mature irregulariter rupto, massam nigram, pulveream sporarum cellularumque sterilium ostendentes. Sporae globosae, subglobosae, raro late ellipsoidales, 18,5-24(-25) $\times$ 18,5-25(-26) μm , pallide usque atro-olivaceobrunneae, raro subopaeae, cum verrucis 1,5-2,5 μm altis, cylindricis vel subpyramidalibus cum typo depresso vel rotundato, in visu superficiali sicut puncta atra, irregulariter polygonalia apparentia, in diametro sporae 6-11, in circumferentia aequatoriali 21-40, in vagina hyalina inclusa. Cellulae steriles subglobosae, ellipsoidales usque parum irregulares, 10,5-17 $\times$ 11-24 μm , subhyalinae usque pallide flavidobrunneo tinctae; pariete 1,5-3 μm crasso, levi vel cum vestigiis ornamenti, contentu granuloso.

Sori in some ovaries of an inflorescence, globoid, ovoid or ellipsoidal, 1.5-2 x 2-4 mm, often with subacute basal part, showing between the spreading floral envelopes, covered by a thick, dark brown peridium which ruptures irregularly at maturity disclosing the black, powdery mass of spores and sterile cells. *Spores* globose, subglobose, rarely broadly ellipsoidal, $18.5\text{--}24(-25) \times 18.5\text{--}25(-26)\text{ }\mu\text{m}$, pale to dark olivaceous-brown, rarely subopaque, provided with 1.5-2.5 μm high cylindrical or subpyramidal warts with a flattened or rounded tip, in surface view appearing as darker, irregularly polygonal spots, 6-11 per spore diam., 21-40 on the equatorial circumference, embedded in a hyaline sheath. *Sterile cells* subglobose, ellipsoidal to slightly irregular, $10.5\text{--}17 \times 11\text{--}24\text{ }\mu\text{m}$, subhyaline to pale yellowish-brown tinted; wall 1.5-3 μm thick, smooth or with a trace of ornament, content granular.

On *Poaceae*: *Setaria pumila* (Poir.) Roem. & Schult.; S Asia (India). Known only from the type locality.

Tilletia setariae-pumilae differs from *T. setariae* in having smaller spores, lower warts, and more warts per spore diam. The spores of *T. setariae* measure 20-28 × 20-30(-33) µm, the warts are 1.5-3 µm high, 8-13 per spore diam., 27-45 on the equatorial circumference.

Acknowledgements

I am grateful to S. Tóth (Gödöllő, Hungary) for preparing the Latin diagnoses, to R.G. Shivas (Brisbane, Australia), and M. Piątek (Kraków, Poland) for fruitful discussions, for reading the manuscript and serving as pre-submission reviewers, to S. Pennycook (Auckland, New Zealand) for taxonomic revision and useful suggestions, to M. Lutz (Tübingen, Germany) for results of molecular biological analyses and fruitful discussions. Many thanks to A.R. and M.S. Patil (Kolhapur, India) for numerous isotype specimens, to H. Scholz (Berlin, Germany) for identifying host plants. Thanks are also due to the Directors and Curators of the Herbaria BPI, BR, BRIJ, HBG, HCIO, IMI and PREM for loans and/or exchange of specimens.

Literature Cited

- Bag MK, Agarwal DK. 2001. Taxonomic studies on smut fungi from North-Eastern India. *Indian Phytopathol.* 54:219-225.
- Bauer R, Oberwinkler F, Vánky K. 1999. *Ustilaginomycetes* on *Osmunda*. *Mycologia* 91:669-675.
- Berkeley MJ., Broome CE. 1873('1875'). Enumeration of the fungi of Ceylon. Part II., etc. *J. Linn. Soc., Bot.* 14:29-140.
- Braun U. 1979. Zur Typisierung der von Schlechtendal beschriebenen Pilze. *Feddes Repert.* 90:409-413.
- Brefeld O. 1895. Untersuchungen aus dem Gesamtgebiete der Mykologie. XII. Hemibasidii. Brandpilze III. Münster i. W., Commissions-Verlag v. H. Schöningh. IV + 99-236 pp. + Pls. VI-XII.
- Bubák F. 1910. Eine neue Ustilaginee der Mohrenhirse. *Z. Landw. Versuchswesen Oesterr.* 1910:53-56.
- Bubák F. 1912. Houby České. Díl II. Sněti (Hemibasidii). *Arch. Přír. Výzk. Čech.* 15(3):1-84.
- Ciferri R, Herter WG. 1932. *Ustilaginales* Uruguayenses; Itinera Herteriana IV. *Bot. Arch.* 34:527-540.
- Ciferri R. 1924. Prima contribuzione allo studio degli *Ustilaginales* (No. 1-22). *Bull. Soc. Bot. Ital.* 1924:46-59.
- Ciferri R. 1928. Quarta contribuzione allo studio degli *Ustilaginales*. *Ann. Mycol.* 26:1-68 + Pl.
- Ciferri R. 1931. Smuts collected in the Dominican Republic by E. L. Ekman. *I. Ark. Bot.* 23 A (14):1-29.
- Ciferri R. 1933. *Ustilaginales* esotici nuovi o rari. *I. Nuovo Giorn. Bot. Ital., N.S.* 40:252-268.
- Ciferri R. 1934. A few interesting North American smuts. *Trans. Brit. Mycol. Soc.* 18:257-264.
- Ciferri R. 1938. *Ustilaginales*. In *Flora Italica Cryptogama, Pars I. Fungi, Fasc. 17*, pp. 1-443.
- Cîrţu D, Ene I, Cîrţu M. 1974. Note mycofloristice din sudul Olteniei. *Stud. Cercet. (Slatina, Romania)* 1974:153-155.
- Clayton WD, Renvoize SA. 1986. *Genera graminum. Grasses of the world.* Kew Bulletin Additional Series XIII. London, UK, 389 pp.
- Clinton GP. 1902. North American *Ustilagineae*. *J. Mycol.* 8:128-156.

- Clinton GP. 1906. Order *Ustilaginales*. In North American Flora 7(1):1-82.
- Dietel P. 1897. Hemibasidii (*Ustilagineae* und *Tilletiineae*). In Engler & Prantl, Die Natürlichen Pflanzenfamilien. I(1)**:2-24.
- Doidge EM. 1950. The South African fungi and lichens to the end of 1945. *Bothalia* 5:1-1045. (*Ustilaginales* pp. 377-393).
- Dumitraş L. 1971. Some contributions to the study of the species *Tilletia sterilis* Ule. *Rev. Roumaine Biol., Ser. Bot.* 16:185-190 + 2 Figs.
- Durán R, Fischer GW. 1961. The genus *Tilletia*. Washington State University, 138 pp.
- Ellis JB. 1893. Descriptions of some new species of fungi. *J. Mycol.* 7:274-278.
- Ellis JB, Everhart BM. 1887. New species of *Ustilagineae* and *Uredineae*. *J. Mycol.* 3:55-57.
- Farr ML. 1973. An annotated list of Spegazzini's fungus taxa. Cramer, 1661 pp.
- Fischer GW. 1952. Some new species of *Ustilaginales* from North America. *Res. Stud. State Coll. Wash.* 20:3-10.
- Fischer von Waldheim A. 1877. Aperçu systématique des Ustilaginées, leurs plantes nourricières et la localisation de leurs spores. Paris, Lahure, 51 pp.
- Fückel L. 1873 (1873 und 1874'). *Symbolae mycologicae. Zweiter Nachtrag. Jahrb. Nassauischen Vereins Naturk.* 27-28:1-99.
- Gandhe RV. 1978. Smuts of Maharashtra. Doctoral Thesis, University of Poona, 270 pp. (Type-written).
- Golovin PN. 1950. Novye vidy gribov Srednei Azii. *Sredneaz. Gosud. Univ., N.S., Vyp. 14, Biol. Nauk., Kniga* 5:1-47, Tashkent.
- Guillemette MK. 1988. *Tilletia togwattii*, a new bunt species from *Poa reflexa*. *Mycologia* 80:273-285.
- Guo L, Vánky K, Mordue JE. 1990. The genus *Franzpetrakia* (*Ustilaginales*). *Mycosystema* 3:57-66.
- Guo L. 2006. Six new species of *Anthracoidea* (*Ustilaginales*) from China. *Fungal Diversity* 21:81-92.
- Gutner LS. 1941. Golovnevye griby. (The smut fungi). *Lenin Acad. Agric. Sci. Inst. Plant Protection. Moscow & Leningrad*, 383 pp.
- Harada Y. 1983. Materials for the smut flora of Japan. I. *Trans. Mycol. Soc. Japan* 24:299-306.
- Hennings P. 1895. *Ustilagineae*. Brandpilze. In Engler, A. (ed.). *Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete. Teil C.* Berlin, pp. 48-49.
- Hennings P. 1896. Beiträge zur Pilzflora Südamerikas I. *Myxomycetes, Phycomycetes, Ustilagineae* und *Uredineae*. *Hedwigia* 35:207-262.
- Hennings P. 1904. Einige neue Pilze aus Japan. *Hedwigia* 43:140-146.
- Hennings P. 1906. Fungi japonici. VI. *Bot. Jahrb. Syst.* 37:156-166.
- Hennings P. 1907. Fungi. In Wildeman de É., *Flore du Bas- et du Moyen-Congo. Ann. Mus. Congo, Sér. 5, Bot.* 2:85-106.
- Hennings P. 1908a. Fungi bahienses a cl. E. Ule collecti. *Hedwigia* 47:266-270.
- Hennings P. 1908b. Einige neue parasitische Pilze aus Transvaal, von Herrn T.B.R. Evans gesammelt. *Bot. Jahrb. Syst.* 41:270-273.
- Hirschhorn E. 1959. Systematic and cytologic characteristics of the *Ustilago* spp. that attack the *Paspalum* in Argentina and Uruguay. In Omagiu lui Traian Săvulescu. *Bucureşti, Edit. Acad.*, pp. 297-316.
- Hirschhorn E. 1986. Las *Ustilaginales* de la flora Argentina. La Plata, CIC, 530 pp.
- Ito S. 1935. Notae mycologicae Asiae orientalis II. *Trans. Sapporo Nat. Hist. Soc.* 14:87-96.
- Jaczewski AA. 1926. Ein neuer Brandpilz auf *Phleum* – *Tilletia paradoxa* sp. n. *Zap. Naučno-Prikl. Otd. Tiflisk. Bot. Sada* 5:169.

- Kakishima M, 1982. A taxonomic study on the *Ustilaginales* in Japan. Mem. Inst. Agr. & For. Univ. Tsukuba 1:1-124.
- Kakishima M, Ono Y. 1988. Three species of smut fungi (*Ustilaginales*) from Nepal. In Watanabe, M. et al. (eds). Cryptogams of the Himalayas. Vol. I. The Kathmandu Valley. Department of Botany, National Science Museum, Tsukuba, Japan, pp. 127-132.
- Karatygin IV, Azbukina ZM. 1989. Opredelitel' gribov SSSR. Porjadok Golovnevye. Vyp. 1. Semejstvo Ustilagovye (Definitorium fungorum URSS. Ordo *Ustilaginales*. Fasc. 1. Familia *Ustilaginaceae*). Nauka, Leningrad.
- Körnicker F. 1872. Ueber einen neuen Brandpilz auf der italienischen Hirse: *Ustilago crameri* Kcke. Verh. Naturhist. Vereines Preuss. Rheinl. Westphalens 29:192.
- Körnicker F. 1877. Mykologische Beiträge. Hedwigia 16:33-40.
- Kulkarni GS. 1922. The smut of nachani or ragi (*Eleusine coracana* Gaertn.). Ann. Appl. Biol. 9:184-186.
- Langdon RFN. 1948. Records of Queensland fungi, V. Univ. Queensland Dept. Biol. Pap. 2(9):1-9.
- Ling L. 1949. Taxonomic notes on Asiatic smuts. I. Sydowia 3:123-134.
- Ling L. 1951a. Taxonomic notes on the *Ustilaginales*. Lloydia 14:101-110.
- Ling L. 1951b. Studies in the genus *Cintractia*. III. *Cintractia leucoderma* and related species. Mycologia 43:310-318.
- Ling L. 1953a. Taxonomic notes on the *Ustilaginales*. II. Lloydia 16:180-192.
- Ling L. 1953b. The *Ustilaginales* of China. Farlowia 4:305-351.
- Ling Y, Chen TL. 1945. Notes on some Fukien species of the family *Ustilaginaceae*. Res. Bull. Inst. Zool. Bot. Fukien Acad. 1:1-26.
- Magnus P. 1878. Drei neue Pilze (*Ustilago Urbani*, *Urocystis primulicola*, *Schinzia cypericola*). Verh. Bot. Vereins Prov. Brandenburg (Sitzb.) 20:50-54.
- Maire R. 1917. Champignons nord-africains nouveaux ou peu connus. Bull. Soc. Hist. Nat. Afrique N. 8:134-200.
- McAlpine D. 1910. The Smuts of Australia. Their structure, life history, treatment, and classification. Melbourne, 285 pp.
- Meiners JP. 1957. Spore germination and cytology of *Tilletia scrobiculata*. Phytopathology 47:528.
- Montemartini L. 1934. Alcune Ustilaginee dell'Eritrea. Boll. Stud. Inform. Reale Giardino Colon. 13(Ser. 3, 7):44-46.
- Mundkur BB. 1940. A second contribution towards a knowledge of Indian *Ustilaginales*. Trans. Brit. Mycol. Soc. 24:312-336.
- Mundkur BB, Thirumalachar MJ. 1946. Revision of and additions to Indian fungi I. Mycol. Pap. 16:1-27.
- Mundkur BB, Thirumalachar MJ. 1952. *Ustilaginales* of India. C. M. I., Kew, 84 pp.
- Nagorny PI. 1926. Eine neue Art *Tilletia* aus dem Kaukasus *Tilletia poae* sp. n. Zap. Naučno-Prikl. Otd. Tiflissk. Bot. Sada 5:170.
- Niessl v. G. 1876. Mycologische Notizen. Hedwigia 15:1-2.
- Patil AR, Patil TM, Patil MS. 2004a. Smuts of Maharashtra VI Genus: *Sporisorium*. J. Mycol. Pl. Pathol. 34:778-791.
- Patil AR, Patil TM, Patil MS. 2004b. Smuts of Maharashtra VII. J. Mycol. Pl. Pathol. 34:838-845.
- Patil BV, Thirumalachar MJ. 1968('1966'). Studies on some fungi of Maharashtra, India. II. Sydowia 20:47-50.
- Patil SD, Gandhe RV. 1975. Nuclear behaviour and life history of *Doassansia khandalensis* sp. nov. Maharashtra Vidnyan Mandir Patrika 10:30-34.
- Pavgi MS, Singh RA. 1967. An interesting *Entyloma* species from India. Canad. J. Bot. 46:939-943.

- Pavgi MS, Thirumalachar MJ. 1957. *Franzpetrakia*, a new genus of the *Ustilaginales*. Sydowia, Beih. 1:(1-3) + Pl. 1.
- Peck CH. 1881. New species of fungi. Bot. Gaz. (Crawfordsville) 6:274-277.
- Peck CH. 1912. Report of the state botanist 1911. New York State Mus. Bull. 157:5-139.
- Piątek M. 2006. *Sporisorium kenyanum*, a new smut fungus with long twisted sori on *Setaria pallide-fusca*. Polish Bot. J., 51:159-164.
- Piepenbring M. 1996. Smut fungi (*Ustilaginales* and *Tilletiales*) in Costa Rica. Beih. Nova Hedwigia 113:1-155.
- Piepenbring M. 2000. The species of *Cintractia* s. l. (*Ustilaginales*, *Basidiomycota*). Nova Hedwigia 70:289-372.
- Piepenbring M. 2002a. Diversity, taxonomy, and ecology of plant parasitic smut fungi in Bolivia. Ecologia en Bolivia 37:49-58.
- Piepenbring M. 2002b. Annotated checklist and key for smut fungi in Colombia. Caldasia 24:103-119.
- Piepenbring M. 2003. Smut fungi (*Ustilaginomycetes* p.p. and *Microbotryales*, *Basidiomycota*). Flora Neotropica. Monograph 86. The New York Botanical Garden Press, New York.
- Rabenhorst L. 1881. Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. 2. Aufl., 1. Pilze, I. Abt., pp. 79-131.
- Raciborski M. 1900. Parasitische Algen und Pilze Java's. Theil II. Batavia.
- Ricker PL. 1905. Notes on fungi II. With new species from various localities. J. Mycol. 11:111-115.
- Saccardo PA. 1888. *Ustilagineae* Tul. (by J.B. De Tony). In Sylloge fungorum, etc. 7:449A-498A, 499-527.
- Saccardo PA. 1899. *Ustilaginaceae* Tul. (by P.A. Saccardo & P. Sydow). In Sylloge fungorum, etc. 14:410-431.
- Schröter J. 1871(1869⁴). Die Brand- und Rostpilze Schlesiens. Jahresber. Schles. Ges. Vaterl. Cult. 49:1-31.
- Schwarzman SR. 1960. Golovnevye griby. (Smut fungi; in Russian). Flora sporovych rastenij Kazachstana 2. Alma Ata. 369 pp.
- Setchell WA. 1891. Preliminary notes on the species of *Doassansia* Cornu. Proc. Amer. Acad. Arts 26:13-19.
- Shen CI. 1934. Notes on *Ustilaginales* from China. Sinensia 4:299-320.
- Spegazzini C. 1880. Fungi argentini (Continuacion). Anales Soc. Ci. Argent. 10:5-33.
- Spegazzini C. 1884. Fungi guaranitici. Anales Soc. Ci. Argent. 17:69-96.
- Spegazzini C. 1899. Fungi argentini novi vel critici. Anales Mus. Nac. Buenos Aires, Ser. 2, 6:81-367 + 2 Pls.
- Spegazzini C. 1925. Ustilagineas Argentinas nuevas o críticas. Revista Argent. Bot. 1:145-156.
- Stoll M, Begerow D, Oberwinkler F. 2005. Molecular phylogeny of *Ustilago* and *Sporisorium*, and related taxa based on combined analysis of rDNA sequences. Mycol. Res. 109:342-356.
- Sydow H, Ahmad S. 1939. Fungi panjabenses. Ann. Mycol. 37:439-447.
- Sydow H, Sydow P, Butler EJ. 1906. Fungi Indiae orientalis. Pars I. Ann. Mycol. 4:424-445.
- Sydow H, Sydow P, Butler EJ. 1912. Fungi Indiae orientalis. Pars IV. Ann. Mycol. 10:243-280.
- Sydow H, Sydow P. 1912. Novae fungorum species. VII. Ann. Mycol. 10:77-85.
- Sydow H, Sydow P. 1916. Fungi amazonici a cl. E. Ule lecti. Ann. Mycol. 14:65-97.
- Sydow H. 1924. Notizen über Ustilagineen. Ann. Mycol. 22:277-291.
- Sydow H. 1929. Fungi chinenses. Ann. Mycol. 27:418-434.
- Thakur SB. 1975. A new species of *Burrillia* from India. Curr. Sci. 44:482-483.

- Thirumalachar MJ, Neergaard, P. 1978('1977'). Studies on the genus *Tolyposporium*. *Tolyposporidium* gen. nov. *Friesia* 11:177-192.
- Thirumalachar MJ, Pavgi MS. 1956. Notes on Indian *Ustilagineae*. VI. *Mycopathol. Mycol. Appl.* 7:282-290 + Pls. I-II.
- Thirumalachar MJ, Pavgi MS. 1968('1967'). Notes on some Indian *Ustilagineae*. IX. *Sydowia* 20:21-27 + Pl. I.
- Thirumalachar MJ, Safeeulla KM. 1951. Some new or interesting fungi. III. *Sydowia* 5:439-443.
- Togashi K, Maki Y. 1940. New species of parasitic fungi II. *Ann. Phytopathol. Soc. Japan.* 10:139-140 + Pl. II.
- Tracy SM, Earle FS. 1895. New species of parasitic fungi. *Bull. Torrey Bot. Club* 22:174-179.
- Ule E. 1884. Beitrag zur Kenntniss der Ustilagineen. *Verhandl. Bot. Vereins Prov. Brandenburg* 25:212-217.
- Uljanishchev VI. 1939. Azerbaydzhanskie vidy roda *Tubercinia* Fries. (Azerbaydzhansk species of the genus *Tubercinia* Fries). In Aleksandrova, N.V. et al. (eds.). *Steblevaya golovnya pshenitsy*. Baku, Azerneshr. pp. 4-14.
- Uljanishchev VI. 1948 (Dokl. Akad. Nauk Azerbaid. SSR 4:491, 1948, n.v.)
- Uljanishchev VI. 1968. *Opredelitel' glovnykh gribov SSSR*. (Key to the smut fungi of the USSR). Leningrad, Izdat. Nauka, 1-182.
- Vánky K, McKenzie EHC. 1990. *Cintractia oreoboli* and *Schizonella isolepidis*, two new species of Ustilaginales on Cyperaceae in New Zealand. *New Zealand J. Bot.* 28:249-253.
- Vánky K, Guo L. 1986(1987). *Ustilaginales* from China. *Acta Mycol. Sinica, Suppl.* 1:227-250.
- Vánky K, Shivas RG. 2003. Further new smut fungi (*Ustilaginomycetes*) from Australia. *Fungal Diversity* 14:243-264.
- Vánky K. 1977. *Moesziomyces*, a new genus of *Ustilaginales*. *Bot. Not.* 130:131-135.
- Vánky K. 1981. Two new genera of *Ustilaginales*: *Nannfeldtiomyces* and *Pseudodoassansia*, and a survey of allied genera. *Sydowia* 34:167-178.
- Vánky K. 1983. Ten new species of *Ustilaginales*. *Mycotaxon* 18:319-336.
- Vánky K. 1985. Carpathian *Ustilaginales*. *Acta Univ. Upsal., Symb. Bot. Upsal.* 24(2):1-309.
- Vánky K. 1986a. The genus *Moesziomyces* (*Ustilaginales*). *Nordic J. Bot.* 6:67-73.
- Vánky K. 1986b. K. Vánky, *Ustilaginales* exsiccata. Fasc. XXI-XXII (Nos. 501-550). Publications from the Herbarium Ustilaginales Vánky (HUV) 3:1-17.
- Vánky K. 1988. Taxonomical studies on *Ustilaginales*. I. *Mycotaxon* 31:401-406.
- Vánky K. 1990. Taxonomical studies on *Ustilaginales*. VI. *Mycotaxon* 38:267-278.
- Vánky K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York.
- Vánky K. 1995a. Taxonomical studies on *Ustilaginales*. XII. *Mycotaxon* 54:215-238.
- Vánky K. 1995b. Taxonomical studies on *Ustilaginales*. XIII. *Mycotaxon* 56:197-216.
- Vánky K. 1998. Proposal to conserve the generic name *Thecaphora* Fingerhuth against *Sorosporium* Rudolphi (Fungi, *Ustilaginales*). *Taxon* 47:153-154.
- Vánky K. 1999. Taxonomical studies on *Ustilaginales*. XIX. *Mycotaxon* 73:135-162.
- Vánky K. 2001. Taxonomical studies on *Ustilaginales*. XXI. *Mycotaxon* 78:265-326.
- Vánky K. 2002. *Illustrated Genera of Smut Fungi*. 2nd ed. APS Press, 238 pp.
- Vánky K. 2003a. The smut fungi (*Ustilaginomycetes*) of *Hyparrhenia* (*Poaceae*). *Fungal Diversity* 12:179-205.
- Vánky K. 2003b. The smut fungi (*Ustilaginomycetes*) of *Sporobolus* (*Poaceae*). *Fungal Diversity* 14:205-241.
- Vánky K. 2004. Taxonomic studies on *Ustilaginomycetes* - 24. *Mycotaxon* 89:55-118.

- Vánky K. 2005. Taxonomic studies on *Ustilaginomycetes* - 25. Mycotaxon 91:217-272.
- Vánky K. 2006a. The smut fungi (*Ustilaginomycetes*) of *Restionaceae* s. lat. Mycol. Balcan. 3:19-44.
- Vánky K. 2006b. Taxonomic studies on *Ustilaginomycetes* - 26. Mycotaxon 95:1-65.
- Wallroth KFW. 1833. Flora Cryptogamica Germaniae. Pars II, Vol. 4. Norimbergae.
- Westendorp GD. 1851. Notice sur quelques cryptogames inédites ou nouvelles pour la flore belge. Bull. Acad. Roy. Sci. Belgique 18:384-417 + Pl.
- Winter G. 1885. New North American fungi. J. Mycol. 1:101-102.
- Zambettakis C. 1980('1979'). Recherches sur les *Ustilaginales*. (Supplément sur les espèces africaines). Bull. Soc. Mycol. France 95:393-443.
- Zogg H. 1983. *Tilletia sabaudiae*, a new smut fungus (*Tilletiales*) and some observations of the gelatinoid sheath of the *Tilletia* spores. Botanica Helvetica 93:91-98.
- Zundel GL. 1930. Monographic studies on the *Ustilaginales* attacking *Andropogon*. Mycologia 22:125-158.
- Zundel GL. 1931. Notes on new species of *Ustilaginales*. Mycologia 23:296-299.
- Zundel GL. 1944. Notes on the *Ustilaginales* of the world. IV. Mycologia 36:400-412.
- Zundel GL. 1945. Notes on a proposed new genus and four new species of the *Ustilaginales*. Mycologia 37:370-373.
- Zundel GL. 1953. The *Ustilaginales* of the world. Contr. Dept. Bot. School Agric. Pennsylvania State Coll. 176:XI + 1-410.

Preliminary checklist of macromycetes of the East and Middle Black Sea Regions of Turkey

ERTUGRUL SESLI

ertugrulsesli@ktu.edu.tr

*KTU Fatih Faculty of Education, Department of Sciences Education
Trabzon TR 61335, Turkey*

Abstract – This study is based on macromycete specimens collected from the East and Middle Black Sea Regions of Turkey in 2002–2005. As a result of field and laboratory studies, 213 taxa were identified. The complete checklist is available on:

<http://www.mycotaxon.com/resources/weblists.html>.

Key words – fungal diversity, mushrooms

Introduction

Turkey is divided into seven geographic regions and each region has different types of landscape and climate. The Black Sea Region extends from the border of Georgia in the east to the eastern edge of the Adapazari plain in the west. The region is divided into east, middle and west sections based on their geographical characteristics.

Turkey displays a great variation in topography and special land-forms. In the north, the East-West oriented, parallel ranges of the Northern Anatolian Mountains run in the southern part of the Black Sea. These coastal mountain ranges are the broadest and the highest in their eastern section, attaining elevations of over 3000 m. In the middle and west only a few peaks exceed 2500 m. The lower parts of the northern regions of Turkey are under the mild and humid climatic conditions. Cold and humid-per humid climate is dominant in the higher parts of this region. Northern Anatolian mountains form a barrier between the Black Sea and inland part of Central Anatolia. Yearly precipitation of the north-facing slopes of Eastern Black Sea Mountains is above 2000 mm (Atalay 1994).

Many studies on the mycota of Turkey have been carried out. Contemporary knowledge of the diversity of Turkish macromycetes is based on 90 years of investigations. The total number of macrofungal species recorded from Turkey



Fig.1. Location of the sampling area.

is 1601 (Sesli & Denchev 2005). Sesli & Baydar (1995, 1996) presented the first macromycete checklists, including the *Russulaceae* and *Agaricales*. Wood decaying macrofungi of the western Black Sea Region of Turkey were studied by Afyon et al. (2005).

The present study was based on specimens collected from the East and Middle Black Sea Regions of Turkey (Fig. 1). The aim of the present study is to examine the mycobiota of these regions of Turkey.

Materials and methods

The material for this study was collected during field trips to the East and Middle Black Sea Regions of Turkey between 2002 and 2005. The color, odor and other apparent properties of the macrofungi and vegetation were noted in the field. Photographs of specimens were taken using Fujicolor negative film and a macroobjective of normal focal length with an extension tube. The macrofungi collected from the study area were kept completely separate and were examined in the laboratory as soon as possible after collection. Spore prints were made to determine the color of the spores and spores from the prints were then used for the measurements. All spore measurements and length/width ratios were calculated from at least 20 spores. Microscopical examinations were performed using Nikon research microscopes. All the instruments were equipped with low voltage illumination. Excised pieces of pilei were moistened by adding a few drops of Clémenton's solution and placed in a damp chamber to soften completely. After being given some time to dry, they were sectioned. The sections were made with a previously unused razor blade under a binocular loupe. The sections were then transferred to a 3 % KOH solution to induce expansion. They were subsequently stained with ammoniated Congo red. The

drawings were made using an apparatus that facilitated work according to precisely fixed magnifications (Sesli et al. 2000).

The specimens were identified using Corner (1966, 1968), Phillips (1981), Moser (1983), Breitenbach & Kränzlin (1984-2000), Singer (1986), Bresinsky & Besl (1990), Stamets (1996), Bessette et al. (1997), Læssøe (2000) and McKenny et al., (1987) and deposited at Fatih Education Faculty Herbarium at Karadeniz Technical University in Trabzon (SES), Turkey.

Results

213 taxa belonging to 55 families of the Ascomycota and Basidiomycota were identified and are listed on the following web page: <http://www.mycotaxon.com/resources/weblists.html>. Habitats, collecting sites, dates and herbarium accession numbers at SES are also given. Abbreviations of authors of fungal names are given according to Kirk & Ansell (1992). The systematics of the taxa are in accordance with Index Fungorum (URL 2007).

Acknowledgements

Financial support was given by the Scientific and Technical Research Council of Turkey [TBAG Project 2051 - 101T068]. I wish to thank Dr. Gro Gulden (Natural History Museum, Oslo, Norway), Dr. D. Jean Lodge (USDA Forest Service, PR, USA), Dr. Shaun R. Pennycook (Manaaki Whenua Landcare Research, Auckland, New Zealand), Dr. Else C. Vellinga (University of California at Berkeley CA, USA) and Dr. Wen-Ying Zhuang (Chinese Academy of Sciences, Beijing, China) for their helpful suggestions and careful review of this manuscript.

Literature cited

- Afyon A, Konuk M, Yagiz D, Helfer S. 2005. A study of wood decaying macrofungi of the western Black Sea Region, Turkey. *Mycotaxon* 93: 319-322.
- Atalay I. 1994. Vegetation geography of Turkey. Izmir, Ege University Press.
- Bessette AE, Bessette AR, Fischer DW. 1997. Mushrooms of northeastern North America. Hong Kong, Syracuse University Press.
- Breitenbach J, Kränzlin F. 1984-2000. Fungi of Switzerland, vols.1-5 Lucerne, Verlag Mykologia.
- Bresinsky A, Besl H. 1990. A colour atlas of poisonous fungi. (Norman Grainger Bisset, transl.). London, Wolfe Publishing Ltd.
- Corner E.J.H. 1966. A monograph of cantharelloid fungi. Cambridge, Oxford University Press.
- Corner E.J.H. 1968. A monograph of *Thelephora* (Basidiomycetes). Cambridge, Verlag von J. Cramer.
- Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of Fungi Supplement CAB International. Wallingford.
- Læssøe T. 2000. Mushrooms. London, Dorling Kindersley Limited.
- McKenny M, Stuntz DE, Ammirati JF. 1987. The new savory wild mushroom. Seattle and London, University of Washington Press.

- Moser M.1983. Keys to Agarics and Boleti (*Polyporales, Boletales, Agaricales, Russulales*). Stuttgart, Gustav Fischer Verlag.
- Phillips R.1981. Mushrooms and other fungi of Great Britain and Europe. Milan, New Interlitho S.p.A.
- Sesli E, Baydar S. 1995. A preliminary checklist of *Russulaceae* of Turkey. *Russulales News* 5: 5-22.
- Sesli, E, Baydar S. 1996. A preliminary checklist of *Agaricales* of Turkey. *Mycotaxon* 60: 213-224.
- Sesli E, Denchev CM. 2005. Checklist of the *Myxomycetes* and *macromycetes* of Turkey. *Mycologia Balcanica* 2: 119-160.
- Sesli E, Wright JE, Türkeku I. 2000. The genus *Tulostoma* Pers. : Pers. (*Gasteromycetes*) in Turkey. *Türk J Bot* 24: 269-272.
- Singer R. 1986. The *Agaricales* in modern taxonomy. Königstein, Koeltz Scientific Books.
- Stamets P. 1996. Psilocybin mushrooms of the world. California, Ten Speed Press.
- URL I. 2007. <http://www.speciesfungorum.org/AuthorsOfFungalNames.htm>.

A new species and two new records of
Erysiphe emend. from China

TIEZHI LIU^{1,2}, XUELIANG BAI¹, YINGCHUN WANG¹ & UWE BRAUN³

tiezhiliu@yahoo.com.cn

¹College of Life Sciences, Inner Mongolia University
Hohhot 010021, China

²Department of Life Sciences, Chifeng College
Chifeng 024001, Inner Mongolia, China

uwe.braun@botanik.uni-halle.de

³Martin-Luther-Universität, Institut für Geobotanik und Botanischer Garten, Herbarium
Neuwerk 21, D-06099 Halle (Saale), Germany

Abstract—A new species of *Erysiphe* sect. *Uncinula*, *Erysiphe yanshanensis* on *Hydrangea bretschneideri* (Hydrangeaceae) is described, illustrated and compared with the morphologically similar *E. hydrangeae*. Two new records for China, *E. indigoferae* (*Erysiphe* sect. *Microsphaera*) on *Indigofera kirilowii* (Fabaceae) and *E. plectranthi* (*Erysiphe* sect. *Erysiphe*) on *Rabdosia japonica* var. *glaucoalyx* (Lamiaceae) are reported.

Key words—powdery mildew fungi, *Erysiphales*, taxonomy

In a series of previous papers (Liu 1998, Liu et al. 2002a,b, 2004; Liu & Wang 2004), information was published on the diversity of powdery mildew fungi (*Erysiphales*) in the Chifeng region of Inner Mongolia, China. However, because of taxonomic uncertainties and similarities to allied species, some collections were misidentified. On the basis of reexamination of problematic collections, the new species *Erysiphe chifengensis* T.Z. Liu & U. Braun was published recently (Liu & Braun 2006). It was noted that specimens on *Hydrangea bretschneideri* should be described as a new species, easily distinguishable from *E. hydrangeae*. Furthermore, it was determined that the collections included two new records for China, *E. indigoferae* on *Indigofera kirilowii* and *E. plectranthi* on *Rabdosia japonica* var. *glaucoalyx*, hitherto only known from Korea (Shin & La 1989a,b). Consistent with current taxonomy of the powdery mildew fungi, the three species are included in *Erysiphe* DC. emend. U. Braun & S. Takam. [sections *Erysiphe*, *Microsphaera* (Lév.) U. Braun & Shishkoff and *Uncinula* (Lév.) U. Braun & Shishkoff] (Braun & Takamatsu 2000, Braun et al. 2002). The materials

studied are deposited at the Mycological Herbarium of the Chifeng College, Inner Mongolia, China (CFSZ), and the Herbarium of the Martin-Luther-University, Halle (Saale), Germany (HAL).

***Erysiphe yanshanensis* T.Z. Liu & U. Braun sp. nov.**

Fig. 1

(belonging in *Erysiphe* sect. *Uncinula*)

Mycobank, MB 510339

Differt a E. hydrangeae appendicibus brevioribus, 50-137(-220) µm, 0-2(-3)-septatis.

Mycelium amphigenous, mostly epiphyllous, effuse, forming thin white patches, irregular, evanescent or subpersistent; **hyphae** hyaline, 3-6.5 µm wide; **appressoria** lobed; **conidiophores** erect, 45-80 µm long, foot-cells cylindrical, 14-29 × 6.5-10 µm, followed by 1-2 cells; **conidia** formed singly, ellipsoid or doliiform-cylindrical, 21-30(-35) × 10-16(-22) (average 26.5 × 14) µm; **ascmata** (chasmothecia) scattered to gregarious, dark brown, depressed globose, 87-137 (average 120) µm diam.; **wall cells** irregularly polygonal, 8-32 µm diam.; **appendages** 5-23, equatorially arising, simple, straight or flexuous, undulate, rarely geniculate, 0.5-1(-1.8) times as long as the ascumatal diam., 50-137(-220) µm long, increasing in width from base toward apex, or width subuniform throughout, but outline sometimes somewhat irregular, with constrictions, sometimes with swellings, 5-10 µm wide near the base, 6.5-13(-16) µm wide above, thin-walled, thick-walled towards the base, smooth or verruculose below, 0-2(-3)-septate, hyaline or pigmented in the lower half, yellowish to brown, paler upwards, hyaline in the upper part, simply uncinately to loosely helicoid at the apex; **asci** (3-)-4-9(-11), oval or oblong, short-stalked to sessile, 45-67 × 26-50 µm (average 60 × 38); **ascospores** (2-)-5-7(-8) per ascus, ellipsoid or ovoid, yellowish, 15-26 × 10-15 (average 23 × 13) µm.

Material examined: On *Hydrangea bretschneideri* (Hydrangeaceae), China, Inner Mongolia: Chifeng, Ningcheng County, Heilihe, ca. 1500 m alt., 5 IX 1997, leg. T.Z. Liu, CFSZ 97057 (holotype); HAL 1938 F (isotype); 3 IX 1997, T.Z. Liu, CFSZ 97049; 25 VIII 1998, T.Z. Liu, CFSZ 98011; 22 VIII 2000, T.Z. Liu, CFSZ 00015; 21 VIII 2006, T.Z. Liu, CFSZ 06088; 22 VIII 2006, T.Z. Liu, CFSZ 06092 (paratypes).

Notes: *Erysiphe hydrangeae* (Z.X. Chen & R.X. Gao) U. Braun & S. Takam. (= *Uncinula hydrangeae* Z.X. Chen & R.X. Gao), known on *Hydrangea paniculata* from the Chinese Province Fujian (Chen et al. 1984, 1987; Chen & Yao 1993, Braun 1987) and Hokkaido in Japan (Braun 1987, Nomura 1997), is the only powdery mildew species of *Erysiphe* sect. *Uncinula* previously described from a host of this genus. This species is characterized by having chasmothecia with consistently long, pluriseptate appendages [1-4 times as long as the ascumatal diam., 0-9(-12)-septate]. Several collections of chasmothecia on *Hydrangea bretschneideri* from the Inner Mongolia Autonomous Region in the northeastern part of China are easily distinguishable from *E. hydrangeae* by

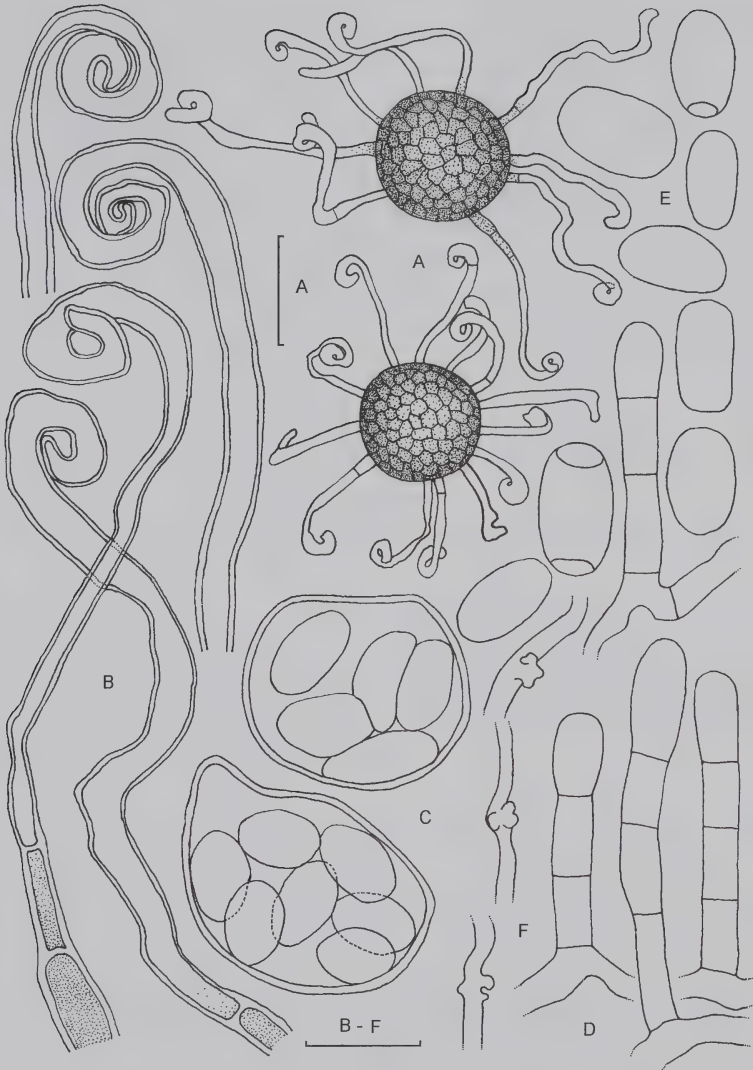


Fig. 1. *Erysiphe yanshanensis* A. Chasmothecia, B. Appendages, C. Asci and ascospores, D. Conidiophores, E. Conidia, F. Hyphae with appressoria.
Bar = 100 μ m (A), 25 μ m (B-F).

having very short appendages, only 0.5-1(-1.8) times as long as the ascomatal diam., with few septa [0-2(-3)-septate]. Based on the common host genus, Liu et al. (2004) tentatively assigned collections on *Hydrangea bretschneideri* to *E. hydrangeae*.

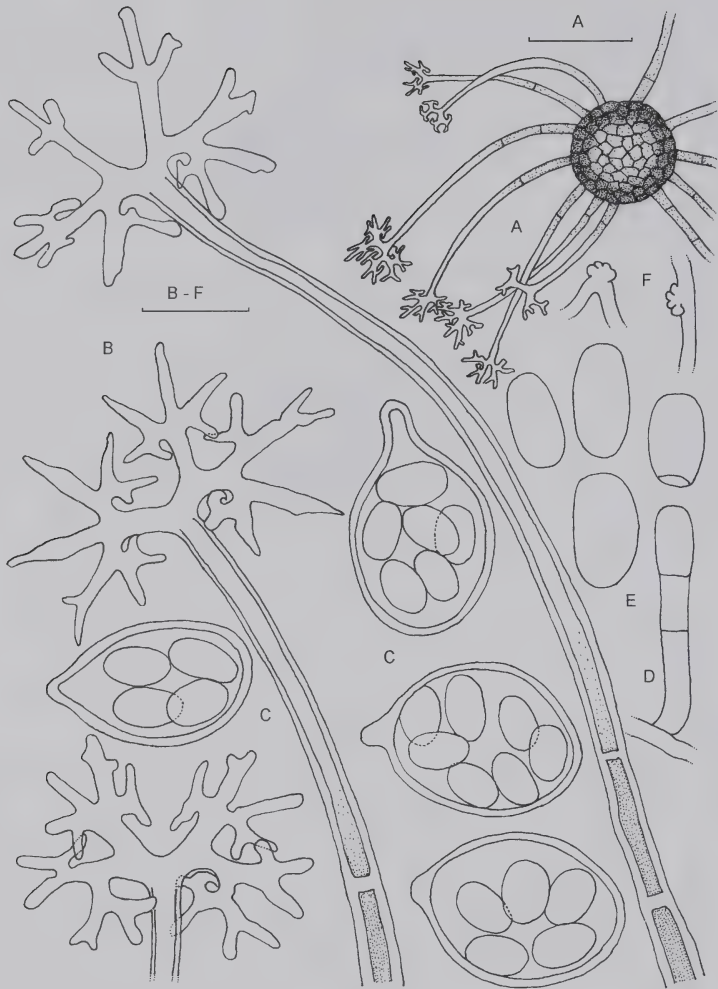


Fig. 2. *Erysiphe indigoferae* A. Chasmothecium, B. Appendages, C. Asci and ascospores, D. Conidiophore, E. Conidia, F. Hyphae with appressoria.
Bar = 100 µm (A), 25 µm (B-F).

Erysiphe indigoferae (H.D. Shin & Y.J. La) U. Braun & S. Takam., Schlechtendalia
4: 9, 2000 Fig. 2
= *Microsphaera indigoferae* H.D. Shin & Y.J. La, Korean J. Pl. Pathol. 5: 258, 1989
(belonging in *Erysiphe* sect. *Microsphaera*)

Mycelium amphigenous, mostly epiphyllous, effuse, forming thin white patches, evanescent to subpersistent; **hyphae** hyaline to subhyaline, 3-7 µm wide, smooth; **appressoria** lobed; **conidiophores** erect, foot-cells cylindrical, flexuous

at the base, $16.5\text{--}23 \times 5\text{--}7\text{ }\mu\text{m}$, followed by 1-2 cells (only few conidiophores observed); **conidia** formed singly, ellipsoid or doliiform-cylindrical, $20\text{--}28 \times 10\text{--}16\text{ }\mu\text{m}$; **ascmata** (chasmothecia) scattered to subgregarious, dark brown, depressed globose, $82\text{--}116\text{ }\mu\text{m}$ diam.; **wall cells** irregularly polygonal, $10\text{--}23\text{--}30\text{ }\mu\text{m}$ diam.; **appendages** 7-15, equatorially arising, straight or curved, flaccid, occasionally long and short appendages mixed on the same ascoma, $(1\text{--})1.5\text{--}3.3$ times as long as the ascomatal diam., $(95\text{--})140\text{--}275\text{ }\mu\text{m}$ long, $7\text{--}10\text{--}11.5\text{ }\mu\text{m}$ wide at the base, narrower upwards, thin-walled, thick-walled towards the base, smooth or rarely verruculose below, $(0\text{--})1\text{--}2$ -septate, brown or light brown below the septum, paler upwards, hyaline in the upper part, apex $(3\text{--})4\text{--}6$ times dichotomously branched, mostly rather regular and compact, sometimes primary branches elongated, branchings looser, tips of the ultimate branchlets straight, subacute, obtuse to subtruncate, ultimate tips rarely recurved; **asci** 4-8, oval, oblong-oval or irregularly shaped, short-stalked to sessile, $43\text{--}63 \times 30\text{--}46\text{ }\mu\text{m}$; **ascospores** 4-7 per ascus, ovoid or ellipsoid, yellowish, $15\text{--}20 \times 10\text{--}13\text{ }\mu\text{m}$.

Material examined: On *Indigofera kirilowii* (Fabaceae), China, Inner Mongolia: Chifeng, Aohan Qi, Daheishan, 13 VIII 1996, T.Z. Liu, CFSZ 96019.

Notes: Because of similarities in the manner of appendage branching and hosts of the same plant family, Liu (1998) identified the fungus on *Indigofera kirilowii* as *Erysiphe robinicola* U. Braun & S. Takam. (= *Microsphaera robiniae* F.L. Tai). Critical re-examination of the collection concerned, however, revealed its identity with *Erysiphe indigoferae* (Shin & La 1989b). This is the first record of this powdery mildew fungus from China.

Erysiphe plectranthi H.D. Shin & Y.J. La, Korean J. Pl. Pathol. 5: 180, 1989 Fig. 3
(belonging in *Erysiphe* sect. *Erysiphe*)

Mycelium amphigenous, mostly epiphyllous, persistent or subsistent on the upper surface of leaves, forming thin white patches and occupying the whole leaf surface, effuse on the lower surface of leaves, subevanescent; **hyphae** hyaline, $3\text{--}7\text{ }\mu\text{m}$ wide; **conidiophores** erect, $(58\text{--})80\text{--}134\text{ }\mu\text{m}$ long, foot-cells cylindrical, $(22\text{--})32\text{--}58 \times 8\text{--}11\text{ }\mu\text{m}$, followed by 1-2 cells, shorter to longer; **conidia** formed singly, ellipsoid to doliiform-cylindrical, $22\text{--}32\text{--}(38) \times 13\text{--}16\text{--}(21)\text{ }\mu\text{m}$; **ascmata** (chasmothecia) scattered to subgregarious, dark brown, depressed globose, $(70\text{--})80\text{--}120\text{--}(130)\text{ }\mu\text{m}$ diam.; **wall cells** irregularly polygonal, $8\text{--}26\text{ }\mu\text{m}$ diam.; **appendages** 10-30, arising from the lower portion of the ascoma, mostly simple, sometimes with short branchlets, rarely with long irregular branches, often undulate to tortuous, sometimes strongly geniculate, $(1\text{--})3\text{--}6$ times as long as the ascomatal diam., $(90\text{--})275\text{--}685\text{ }\mu\text{m}$ long, $2.5\text{--}8\text{--}(10)\text{ }\mu\text{m}$ wide, thin-walled, smooth to somewhat verruculose, $(1\text{--})2\text{--}5\text{--}(7)$ -septate, yellowish to pale brown in the basal half, paler towards the apex, hyaline at



Fig. 3. *Erysiphe plectranthi*

A. Chasmothecium, B. Appendages, C. Asci and ascospores, D. Conidiophores, E. Conidia.
Bar = 100 μ m (A), 25 μ m (B-E).

the upper portion; asci 3-11, oval, oblong-oval or irregularly shaped, sessile or short-stalked, $42-67 \times 29-45 \mu$ m; ascospores (4)-5-7(-8) per ascus, ovoid or ellipsoid, yellowish, $16-22 \times 10-13 \mu$ m.

Material examined: On *Rabdosia japonica* var. *glaucocalyx* [= *Isodon glaucocalyx*; = *Plectranthus glaucocalyx*] (Lamiaceae), China, Inner Mongolia: Chifeng, Songshan District, Wushijiazi, 23 IX 2001, T.Z. Liu & J. Ao, CFSZ 01036, HAL 1936 F.

Notes: Compared to the original description of *Erysiphe plectranthi* (Shin & La 1989a), the appendages in the present collection from China are more numerous

(10-30 per chasmothecium) and (1-)-2-5(-7)-septate [versus 8-18 appendages per chasmothecium, and (1-)-2-3-septate], the asci are (4-)-5-7(-8)-spored, and the ascospores are smaller, $16-22 \times 10-13 \mu\text{m}$ [versus 6-8-spored and $22-27 \times 12-15 \mu\text{m}$]. However, these differences are regarded as modifications in *E. plectranthi*. This powdery mildew fungus is new to China, with *Rabdosia japonica* var. *glaucocalyx* a new host plant for this fungus.

Acknowledgments

The authors are grateful to Drs. Hyeon Dong Shin and Dean A. Glawe for critical comments on the manuscript and for serving as pre-submission reviewers, to Dr. Shaun R. Pennycook for nomenclatural review and for his valuable comments and suggestions. The first author sincerely thanks Dr. Hyeon Dong Shin for providing useful information.

Literature cited

- Braun U, Takamatsu S. 2000. Phylogeny of *Erysiphe*, *Microsphaera*, *Uncinula* (*Erysipheae*) and *Cystotheca*, *Podosphaera*, *Sphaerotheca* (*Cystothecaceae*) inferred from rDNA ITS sequences – some taxonomic consequences. *Schlechtendalia* 4: 1-33.
- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). *Nova Hedwigia*. Beiheft 89: 1-700.
- Braun U, Cook RTA, Inman AJ, Shin HD. 2002. The taxonomy of the powdery mildew fungi. 13-55. in: RR Bélanger et al. (eds), *The powdery mildews: a comprehensive treatise*. APS Press: St. Paul (USA).
- Chen GQ, Han SJ, Lai YQ, Yu YN, Zheng RY, Zhao ZY. 1987. *Flora fungorum Sinicorum*. Vol. 1, *Erysiphales*. Science Press: Beijing (China). 552 pp. [In Chinese].
- Chen ZX, Yao YJ. 1993. *Powdery mildews in Fujian*. Fujian Science and Technology Press: Fuzhou (China). 120 pp. [In Chinese].
- Chen ZX, Gao RX, Luo SB, Liu BC. 1984. New species of powdery mildews from Wuyishan. *Acta Mycol. Sinica* 3: 75-80. [In Chinese].
- Liu TZ. 1998. Investigation of powdery mildew on trees and their pathogenic identification in South Chifeng. *Forest Pest and Disease* 1: 15-18, 39. [In Chinese].
- Liu TZ, Braun U. 2006. A new species of *Erysiphe* sect. *Microsphaera* from Inner Mongolia, China. *Nova Hedwigia* 83: 493-498.
- Liu TZ, Wang YC. 2004. *Erysiphales* of the Chifeng regions of NeiMongol IV: *Microsphaera* and *Podosphaera*. *Acta Sci. Nat. Univ. NeiMongol* 35: 234-237. [In Chinese].
- Liu TZ, Qin XC, Wang YC. 2002a. *Erysiphales* of the Chifeng Regions of NeiMongol I: *Arthrocladiella*, *Blumeria*, *Sphaerotheca*. *Acta Sci. Nat. Univ. NeiMongol* 33: 57-61. [In Chinese].
- Liu TZ, Qin XC, Wang YC. 2002b. *Erysiphales* of the Chifeng Regions of NeiMongol II: *Erysiphe*. *Acta Sci. Nat. Univ. NeiMongol* 33: 177-181. [In Chinese].
- Liu TZ, Wang YC, Xia H. 2004. *Erysiphales* of the Chifeng Regions of NeiMongol III: *Leveillula*, *Phyllactinia*, *Sawadaea* and *Uncinula*. *Acta Sci. Nat. Univ. NeiMongol* 35: 115-118. [In Chinese].
- Nomura Y. 1997. *Taxonomical study of Erysiphaceae of Japan*. Yokendo LTD.: Tokyo (Japan). 281 pp. [In Japanese].
- Shin HD, La YJ. 1989a. Three new species of *Erysiphe* from Korea. *Korean J. Pl. Pathol.* 5: 178-184.
- Shin HD, La YJ. 1989b. Teleomorph of *Oidium indigoferae* Yen from Korea. *Korean J. Pl. Pathol.* 5: 257-261.

Two new *Alternaria* species from selenium-rich habitats in the Rocky Mountain Front Range

AMI L. WANGELINE* & F. BRENT REEVES

*amilea99@hotmail.com

Department of Biology, Colorado State University
Fort Collins, CO 80523 USA

Abstract—Two new small-spored species, *Alternaria seleniiphila* and *Alternaria astragali*, are described.

Key Words— *Astragalus*, Colorado, selenium tolerance, *Stanleya*, Wyoming

Introduction

Alternaria is a large and diverse genus of important plant and animal pathogens, endophytes, and plurivorous saprobes. Based on morphology as well as sequence analysis, *Alternaria* has several close relatives including *Embellisia*, *Ulocladium*, *Stemphylium* (Simmons 1967, 1983; Chou & Wu 2002). Our current concepts of these genera originated with E. G. Simmons' classic paper (Simmons 1967) that updated and recognized *Alternaria*, *Stemphylium*, and *Ulocladium*. *Alternaria* is separated into 14 species groups based on conidial morphology, catenation and the overall 3-D structure of the conidiophore (Simmons 1992). Distinct morphological species-groups (Simmons & Roberts 1993), e.g. the *alternata* group or the *arborescens* group, place similar species into recognizable subgeneric groups that can be separated morphologically, molecularly (Roberts et al. 2000) and chemically (Andersen et al. 2002).

Some members of *Alternaria*, *Embellisia*, and *Ulocladium* have been found in "toxic" habitats containing high levels of metal or metalloid elements such as zinc, lead and selenium (David et al. 2000, Thompson-Eagle et al. 1989) as well as other extreme environments including high salinity and low temperatures (Guiraud et al. 1995, Simmons 1983). The current paper describes two new small-spored *Alternaria* species that were isolated from the roots of plants that hyperaccumulate selenium (Se). These plants are known as "indicators" for soils derived from seleniferous parent material and are found throughout the central and western USA (Beath et al. 1939).

Materials and methods

Stanleya pinnata (Pursh) Britton and *Astragalus bisulcatus* (Hook.) A. Gray were collected from Pine Ridge Natural area in Fort Collins, CO (40°32.70' N, 105°07.87' W, 5177 ft)^a and a private ranch in Laramie, WY (42°51.17' N, 106°31.07' W, 5561 ft)^a, respectively. One-cm cuttings of the feeder roots were surface disinfested by immersion for 10 seconds in 10% (v/v) household bleach solution (6% sodium hypochlorite), rinsed in sterile water and placed in plastic Petri dishes containing 0.5 strength Malt Extract Agar (0.5 MEA, Difco, Detroit, MI, USA) with either 10 mg L⁻¹ Se (*S. pinnata*) or without Se (*A. bisulcatus*), supplied as sodium selenate, Na₂SeO₄ (Sigma Chemical, Chicago IL, USA). The Petri dishes were sealed and incubated at 22 C under continuous fluorescent light. The resulting cultures were subsequently single-spored and maintained on 0.5 MEA at 22 C under continuous light in sealed Petri dishes.

Morphological examination

A 2mm cube from each maintenance culture was transferred to the surface of V-8 juice agar (800 mL H₂O, 200 mL V-8 juice, 3 g CaCO₃, 15 g agar) and incubated at 22 C in unsealed Petri dishes under fluorescent light with 8 hour day/16 hour night cycle for 4 days. Additionally, to observe the undisturbed conidiophores, 1 × 1.5 cm agar plugs were inoculated in the center, placed between a glass slide and cover slip on top of a wet filter paper disk within a sealed plate, and incubated as above.

DNA extraction, PCR amplification, sequencing and sequence analysis

A 2mm cube from each maintenance culture was transferred to 30 mL of Czapek-Dox broth (Difco, Detroit, MI, USA) and grown at 22 C for 5 days under continuous light; a 1 cm diameter colony was harvested for DNA isolation. DNA was extracted with a MasterPure Yeast DNA purification kit and amplified with a FailSafe PCR System (Epicentre Biotechnologies, Madison, WI, USA) using primers ITS1 and ITS4 (White et al. 1990). The PCR products (approx. 540 bp) were purified and the ITS region (ITS1+5.8S+ITS2) was sequenced by MacroGen (Rockville, MD, USA). Sequences were deposited in GenBank (accessions EF110522 and EF110523).

^a global positioning system coordinates

Taxonomic description

Alternaria astragali Wangeline & E.G. Simmons sp. nov.

Figure 1 (A-C)

MYCOBANK #: MB510572

Ex cultura in agaro V-8 descripta. Hyphae in superficie agari distincte radiales. Conidiophora primaria fusca, erectiuscula, ad ca. 250-400 × 3-5 µm. Conidia ovoidea vel longiellipsoidea, 10-35 × 5-7 µm, 0-7 transverse septata, longiseptis nullis vel 1-longiseptata in 1 segmento transverso, dilute vel modice brunnea, laevia, 4-10-catenulata. Conidiophora secundaria nunc unicellularia, ca. 3 × 3 µm, nunc 30-100 × 3-4 µm, nunc conspicue ad 250-300+ µm longa.

Habitatio typi in radice Astragalus bisulcatus, coll. A. Wangeline, 8 June 2002, Laramie, Wyoming, U.S.A. Holotypus: pars ex cultura E.G.S. 52.122 (ex isol. A. Wangeline A-3, 12 June 2002) desiccata et in BPI 872198 conservanda.

Etym: L., *Astragalus* (as host source)

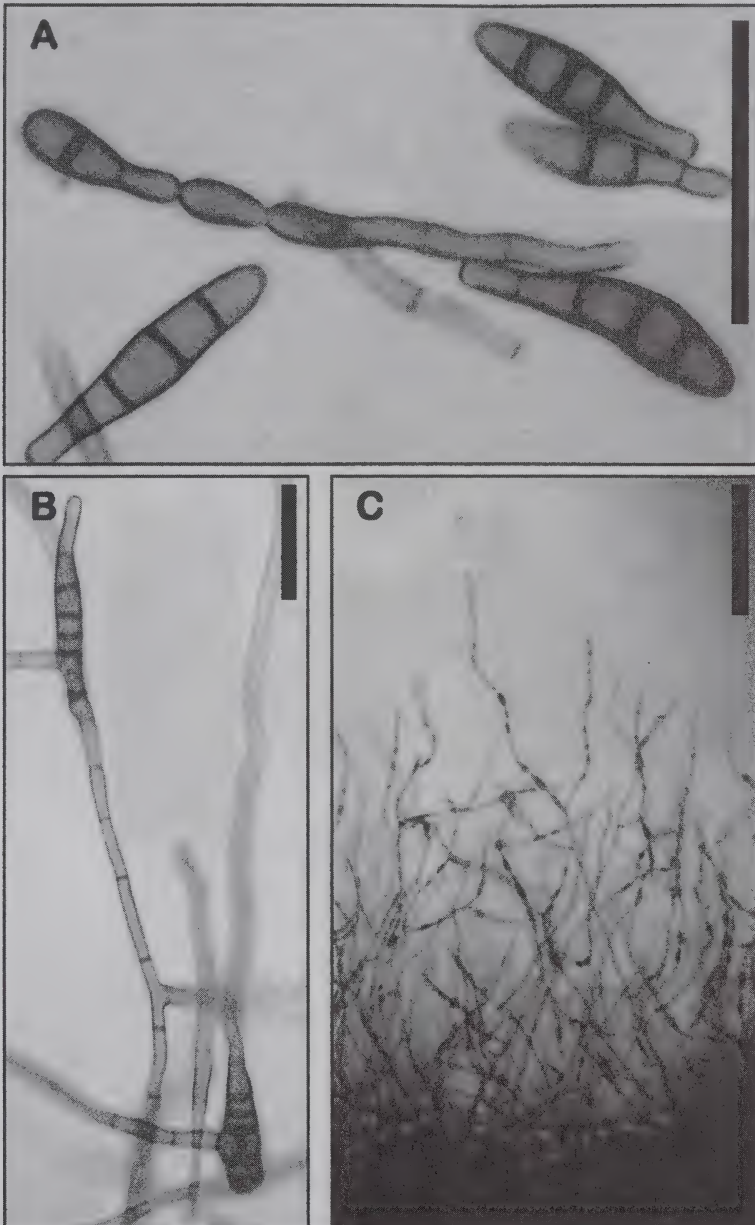


Figure 1. *Alternaria astragali*. Conidia (A), conidiophore showing secondary branching (B), and whole conidiophores (C) exhibiting characteristic sporulation pattern.

Bars = 20 μ m for A and B, and 200 μ m for C.

On V-8 agar: **colony** of radiating surface hyphae bearing abundant, crowded, semi-erect primary conidiophores; **primary conidiophores** of variable length, commonly $250\text{--}400 \times 3\text{--}5\text{ }\mu\text{m}$ usually unbranched with an apical chain of 4–10 conidia; **conidium bodies** ovoid or predominantly long-ellipsoid, $10\text{--}35 \times 5\text{--}7\text{ }\mu\text{m}$, with 0–7 transverse septa and usually no longitudinal septa, or occasionally with a single longiseptum in one of the widest transverse segments, dilute to medium dull brown, septa slightly darker, outer wall appears smooth; **secondary conidiophores** are usually a single apical cell but in most chains at least one, sometimes two conidia produce longer secondary conidiophores $30\text{--}100\text{ }\mu\text{m}$ long, in addition, a very high percentage of small conidia produce an apical secondary conidiophore that is $250\text{--}300\text{ }\mu\text{m}$ or more in length.

Comments—The strikingly long secondary conidiophores are diagnostic of the taxon; they are intermixed with the even longer primary conidiophores, yielding a tangled thicket of dark, erect or variously twisted elements that bear the inconspicuous chains of small spores.

Alternaria seleniiphila Wangeline & E. G. Simmons sp. nov.

Figure 2 (A–C)

MYCOBANK #: MB510571

Ex cultura in agaro V-8 descripta. Conidiophora primaria fusca, erectiuscula vel diverse torta, plerumque sine ramis, $80\text{--}250 \times 4\text{--}5\text{ }\mu\text{m}$. Conidia ovoidea vel ellipsoidea, ad $20\text{--}40 \times 8\text{--}12\text{ }\mu\text{m}$, 1–7 transverse septata, 1-longi- vel oblique septata in 1–3 segmentis transversis, dilute vel modice brunnea, laevia vel punctata, 3–6-catenulata. Conidiophora secundaria vulgo 1–5-cellularia, $3\text{--}30 \times 3\text{ }\mu\text{m}$, etiam plerumque conspicue $50\text{--}110\text{ }\mu\text{m}$ longa.

Habitatio typi in radice Stanleya pinnata, coll. A. Wangeline, 19 June 2002, Fort Collins, Colorado, U.S.A. Holotypus: pars ex cultura E.G.S. 52.121 (ex isol. A. Wangeline A-1, 20 June 2002) desiccata et in BPI 872197 conservanda.

Etym.: NL, *selenium* + *-phila* (having a strong affinity for selenium)

On V-8 agar: **colony** of abundant but not densely crowded long, erect or variously twisted primary conidiophores, $80\text{--}250 \times 4\text{--}5\text{ }\mu\text{m}$ at maturity; **primary conidiophores** are simple or occasionally branched near the point of origin from surface vegetative hyphae usually unbranched within their aerial length, occasionally 1–2 geniculate conidiogenous extensions near apex, each simple conidiophore bears a short, usually unbranched apical chain of 3–6 conidia, occasionally a lateral secondary conidiophore and 1–2 conidia produced by an intercalary conidium in a chain; conidia produced in close succession with short 1–5-celled secondary conidiophore connectives ca. $3\text{--}30 \times 3\text{ }\mu\text{m}$, very long **secondary conidiophore** commonly produced from individual conidia in the chain terminating in 1–3 small conidia, these conspicuous secondary conidiophores are $50\text{--}110\text{ }\mu\text{m}$ long; **conidium bodies** are ovoid to ellipsoid without distinctive beak portion, maximum size range of ca. $20\text{--}40 \times 8\text{--}12\text{ }\mu\text{m}$ at maturity, with 1–7 transverse septa and one longitudinal or oblique septum



Figure 2. *Alternaria seleniphila*. Conidia (A), conidiophore tips (B), and whole conidiophores (C) exhibiting characteristic sporulation pattern. Bars = 20 μ m for A and B, and 200 μ m for C.

in 1-3 of the transverse segments of some conidia, dilute to medium tan with slightly darker septa, outer wall smooth to evenly punctate.

Comments—Various researchers have demonstrated that conidial size is an ineffective identification criterion when used alone to distinguish small-spored species of *Alternaria* (Simmons 1967, Andersen et al. 2002) and misuse of this feature has lead to rampant misidentification, especially in the case of *A. alternata*. There are standardized methods that should be used for morphological identification (Simmons 1992, Roberts et al. 2002) including observation of the appearance and branching habit of the distinct conidiophores of the small-spored *Alternaria* species. *A. astragali* and *A. seleniiphila* have unique conidiophore sporulation patterns specifically in relation to the length of their secondary conidiophores that are diagnostic for each taxon and which differ from that described for *A. alternata* (Simmons 1967, 1992).

A. astragali and *A. seleniiphila* exhibit Se tolerance, showing no visible effects when grown on agar containing 10mg L⁻¹ Se and grow to 0.95 and 0.61, respectively, of control cultures after 5 days on agar containing 600mg L⁻¹ Se. This ability is not unexpected due to their origin from seleniferous host material, as well as the presence of *Alternaria* and related genera in a variety of harsh environments. The ability of the described species to tolerate Se will likely contribute to further taxonomic distinction under metabolite examination. Furthermore, due to the frequent misidentification of *A. alternata*, as well as its reported association with toxic Se environments, it is possible that previous reports of Se tolerant *Alternaria* could be isolates of one of these newly described species (Thompson-Eagle et al. 1989).

The ITS region (ITS1+5.8S+ITS2) of both *A. astragali* and *A. seleniiphila* were sequenced and submitted to GenBank for reference, but should not be used for identification purposes since this gene does not resolve closely related species in this group (Andersen et al. 2002).

Acknowledgements

The authors thank Dr. Mary Palm and Dr. Rodney Roberts for their expert review and comments. Additionally, the authors extend their deepest gratitude to Dr. Emory G. Simmons for his assistance in the identification and the description of the new species as well as many fruitful discussions on dealing with *Alternaria*.

Literature Cited

- Andersen B, Kroger E, Roberts RG. 2002. Chemical and morphological segregation of *Alternaria arborescens*, *A. infectoria* and *A. tenuissima* species-groups. *Mycological Research* 106: 170-182.
- Beath OA, Gilbert CS, Eppson HF. 1939. The use of indicator plants in locating seleniferous areas in Western United States. I. General. *American Journal of Botany* 26: 257-269.
- Chou HH, Wu WS. 2002. Phylogenetic analysis of internal transcribed spacer regions of the genus *Alternaria*, and the significance of filament-beaked conidia. *Mycological Research* 106: 164-169.
- David JC, Coles K, Fisher J, Moss ST. 2000. A new species of *Embellisia* from soil with high levels of heavy metals. *Mycoscience* 41: 533-537.
- Frankenberger WT, Arshad M. 2001. Bioremediation of selenium-contaminated sediments and water. *BioFactors* 14: 241-254.
- Guiraud P, Steiman R, Seigle-Murandi F, Sage L. 1995. Mycoflora of soil around the Dead Sea: II. Deuteromycetes (except *Aspergillus* and *Penicillium*). *Systematic and Applied Microbiology* 18: 318-322.
- Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species groups. *Mycological Research* 104: 151-160.
- Simmons EG. 1967. Typification of *Alternaria*, *Stemphylium*, and *Ulocladium*. *Mycologia* 59: 67-92.
- Simmons EG. 1983. An aggregation of *Embellisia* species. *Mycotaxon* 17: 216-245.
- Simmons EG. 1992. *Alternaria* taxonomy: current status, viewpoint, challenge 1-35, in J Chelkowski and Visconti A (eds.), *Alternaria: biology, plant diseases and metabolites*. Amsterdam, Elsevier.
- Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). *Mycotaxon* 48: 109-140.
- Thompson-Eagle ET, Frankenberger WT, Karlson U. 1989. Volatilization of selenium by *Alternaria alternata*. *Applied and Environmental Microbiology* 55: 1406-1413.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. 315-322, in MA Innis et al. (eds.), *PCR Protocols: a guide to methods and applications*. San Diego, Academic Press.

Three new lichen species from the French Antilles

DAG OLAV ØVSTEDAL

dag.ovstedal@bm.uib.no

Bergen Museum, DNS, University of Bergen

Allégaten 41, N - 5007 Bergen, Norway

JOHN A. ELIX

John.Elix@anu.edu.au

Department of Chemistry, Faculty of Science, Australian National University

Canberra, A.C.T. 0200, Australia

Abstract — *Fuscopannaria caribbea*, *Lecanora legalloana* and *Sporopodium leprosum* from the French Antilles are described as new to science.

Key words — West Indies, taxonomy

Introduction

The number of lichen species reported from the West Indies now exceeds 1800 (Imshaug 1957, Breuss 1999). However, many groups have not been critically revised, so that the number of reported species may ultimately be reduced even though some taxa have yet to be described. A comprehensive list of the lichens of Guadeloupe is currently being prepared (Øvstedal in prep.). Most of the material examined in the present study was collected by the French botanist C. Le Gallo in Guadeloupe and St. Barthelemy during 1956–58. Part of his herbarium was purchased by Henry Imshaug and deposited in MSC (Fryday pers. comm.), while his other collections are present in various herbaria (e.g. PC, US). During our study of the lichens from these islands several new species were discovered and they are described here.

Materials and methods

The specimens studied are deposited in MSC or BG. The lichen specimens were examined using a Zeiss Stemi 2000C stereo microscope and a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomic descriptions

Fuscopannaria caribbea Øvstedal, sp. nov.

Fig. 1

MB 510342

Thallus squamulosus, fusco-brunneus, marginis coeruleis. Apothecia cupuliformes, pallide brunnescens. Prothallus et hypothallus nullus. Ascospores 9-10 x 4-5 µm. Acida lichena ignota.

Etymology: The specific epithet derives from the occurrence of this species on the Caribbean island of Guadeloupe.

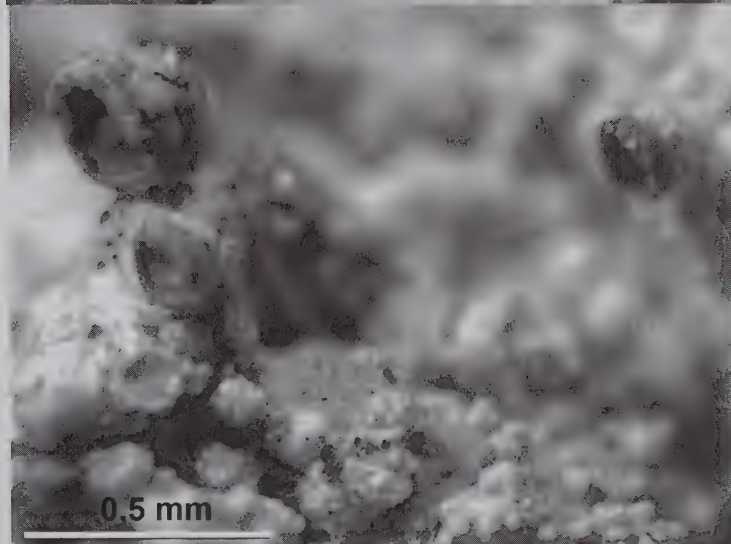
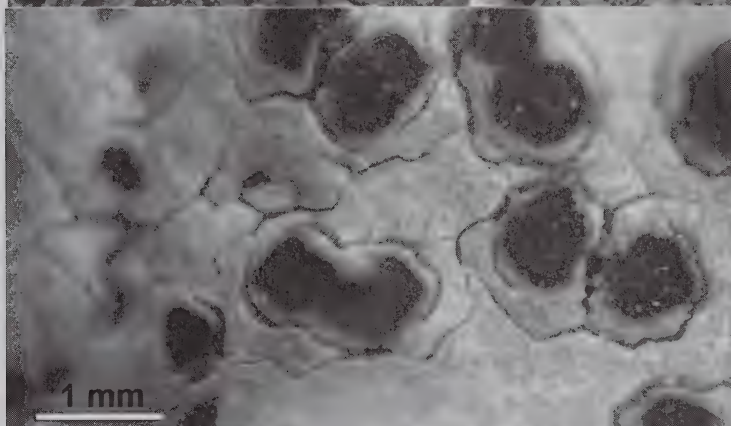
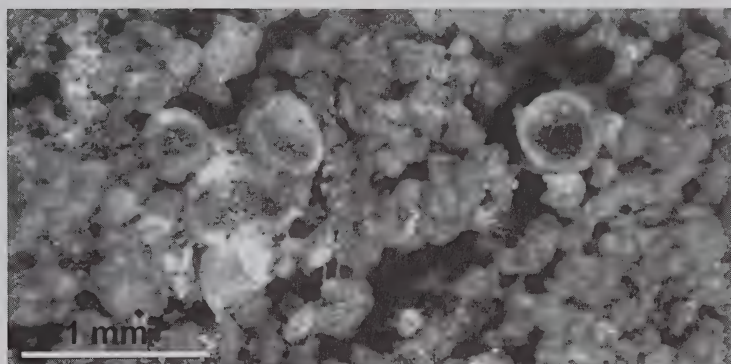
Holotype: GUADELOUPE, French Antilles, Trois Rivières, sur un gros rocher, C. Le Gallo, 25 Nov. 1956; MSC 61008.

KEY CHARACTERS — **Thallus** squamulose, 4-5 cm wide. Photobiont *Nostoc*, in clumps. Squamules overlapping and partly coalescing, individual squamules subterete, ascending, isidioid, to 0.3 mm long and 0.1 mm broad, olivaceous brown, with bluish, fluffy tips. Squamules at the thalline margin up to 0.7 mm wide, fan-shaped, procumbent, with bluish, swollen, fluffy margins. No prothallus or hypothallus observed. **Apothecia** scattered, sessile, lecanorine, cupuliform, pale brown, up to 0.4 mm wide. In vertical section the thalline exciple is filled with clumps of *Nostoc*, and comprises a thin cortex of weakly differentiated pseudoparenchymatous tissue, and a very narrow, colourless, true exciple. Hypothecium colourless. Hymenium 50-60 µm high, K/I + pale blue-green changing to pale reddish. Ascospores 8 per ascus, 9-10 x 4-5 µm, rugulose. **Chemistry** — K–, C–, KC–, Pd–; no lichen substances detected by TLC.

Distribution and Ecology — At present this species is known only from the type locality on Guadeloupe where it grows on organic material (fibrous remains of ferns).

COMMENTS — Previously *F. leucosticta* (Tuck.) P. M. Jørg. was the only *Fuscopannaria* known from the Caribbean region [Cuba] (P. M. Jørgensen pers. comm.). This new species is unique within the genus because of its small, cupular apothecia and readily detached lobe-ends that function as dispersal units (P. M. Jørgensen pers. comm.). Diverse types of vegetative diaspores are known in the genus. For example, *F. albomaculata* P. M. Jørg. from China has marginal lobes that are inrolled and tubiform and easily detached, while *F. granulifera* P. M. Jørg. & Upreti from the Himalayas has granules on the margins (Jørgensen 2004). Further, the recently described *F. venusta* P.M. Jørg. & Sipman from New Guinea has isidia-like outgrowths (Jørgensen & Sipman 2006), while numerous species are sorediate.

Figures 1-3. New species from the French Antilles: 1, *Fuscopannaria caribbea* (holotype); 2, *Lecanora legalloana* (lectotype); 3, *Sporopodium leprosum* (holotype).



***Lecanora legalloana* Elix & Øvstedal, stat. & nom. nov.**

Fig. 2

MB 510343

Basionym: *Lecanora prosecha* var. *rubescens* Vain., Journ. Bot. 34: 5 (1896).*Lectotype* here designated: Dominica, Soufrière, 2.7.1892, W. R. Elliott (TUR-VAIN 05078).*Etymology:* named in honour of the French lichen collector C. Le Gallo.

KEY CHARACTERS — **Thallus** crustose, flat, continuous to rimose-areolate, smooth, yellowish white, epruinose, 150–200 µm thick; with an indistinct, ca. 10 µm thick cortex of pseudoparenchymateous tissue below which lies a fairly compact medulla containing algae and some vertical rows of large, colourless crystals. Soralia absent. Prothallus thin, black, delimiting the thalli by dark lines. **Apothecia** immersed in the thallus, to 0.8 mm wide, disc mid- to dark red-brown, epruinose. Epihymenium red-brown, K–, N–, C–. Hymenium hyaline, 40–45 µm high. Hypothecium and subhymenium colourless. Paraphyses thin, slightly branched, strongly adglutinated, apical cells thickened, to ca. 2 µm wide. Ascospores 8 per ascus, simple, colourless, thick-walled, ellipsoid, 7–9 x 4–5 µm. **Chemistry** — K+ yellow, C–, Pd+ yellow, pigmented part of medulla K+ red-violet; containing atranorin (major), skyrin (major), rugulosin (minor) and traces of diploicin, caloploicin and 4,5-dichlorolichexanthone (most probably the result of contamination from other lichen thalli on the same rock).

Distribution and Ecology — At present this species is known from Guadeloupe, Dominica and St. Vincent where it grows on volcanic rocks.

COMMENTS — *Lecanora legalloana* is characterized by the conspicuous, immersed, aspiciloid apothecia, and the presence of atranorin, skyrin and rugulosin in the medulla. The pigmented areas of the medulla appear as irregular spots which react K+ intense red-violet. Morphologically *L. legalloana* closely resembles the pantropical species, *L. subimmersa* (Fée) Vain. (Lumbsch 1994), but the ascospores of the latter species are much larger (8.5–14.5 x 4.5–5.5 µm cf. 7–9 x 4–5 µm) and it contains atranorin (major), chloroatranorin (minor) and zeorin (major). The closely related *L. subimmersa* subsp. *ramboldii* Lumbsch & Elix, which is recorded from the Caribbean (Guderley 1999), contains additional xanthonenes (Lumbsch 1994).

Vainio (1896) described this taxon as *Lecanora prosecha* Ach. var. *rubescens* but overlooked the fact that the type of *L. prosecha* was sorediate and described a sorediate form of this species (*L. prosecha* f. *granulifera* Vain.) in the same paper. The type of *L. prosecha* (St. Barthelemy, H-ACH 1173) contains atranorin (major), chloratranorin (minor), arthothelin (minor), skyrin (minor) and 4,5-dichloronorlichexanthone (trace), while the type of *L. prosecha* var. *granulifera* (Dominica, Soufrière, W.R. Elliott, TUR-VAIN 06754) contains atranorin (major), chloroatranorin (trace), arthothelin (submajor), 4,5-

dichloronorlichexanthone (trace) and 2,5-dichloronor-lichexanthone (trace). Both *L. legalloana* and *L. prosecha* occur in the same lichen community on Guadeloupe. To add to the confusion, a third whitish, sorediate, sterile lichen often co-occurs with them. This latter was identified as *Caloplaca diplacioides* (Vain.) Zahlbr. and contains diploicin (major), atranorin (minor), caloploicin (minor), fulgidin (trace) and norcanesolide (trace) [fertile specimen: Guadeloupe, Gourbeyre, C. Le Gallo, 22 May 1958 (MSC)].

SPECIMENS EXAMINED— Dominica, Souffrière, W. R. Elliott, 2 Jul. 1892 (TUR-VAIN 05078, lectotype). Guadeloupe, Afstricto, C. Le Gallo, *sine dato* (MSC); Basse-Terre, rivière Sence, sur rochers, C. Le Gallo, 19 Mar. 1957 (MSC).

***Sporopodium leprosum* Øvstedal & Elix, sp. nov.**

Fig. 3

MB 510341

Thallus crustaceus, albus, leprosus, cum campylidis. Acida diversa continens (vide infra). Apothecia non vidi.

Etymology: the epithet derives from the leprose upper surface of the thallus.

Holotype: GUADELOUPE, French Antilles, Basse-Terre, Mamelle de Petit-Burg, on undetermined tree, D. O. Øvstedal, 28 Nov. 1988: BG.

KEY CHARACTERS — **Thallus** leprose, thick, white, with campylidia. **Campylidia** opening sideways, with a single cavity (like a ship's ventilator), ca. 0.3 mm wide and high, surface as for the thallus; cavity concave, smooth, brown. In vertical section the inner and lower parts of a campylidium are composed of pseudoparenchymatous tissue, but towards the surface of the cavity the hyphae become elongated and encrusted with small crystals, terminating in elongate, conidiophorous hyphae. Conidia colourless, simple, filiform, nonseptate, broader in the middle, 18–22 x 1–2 µm, encrusted with minute crystals. No apothecia or pycnidia seen. **Chemistry** — K–, C+ orange, KC+ orange, Pd–; containing methyl barbatate (major), chodatin (minor), isoarthothelin (minor), 5,7-dichloro-3-O-methylnorlichexanthone (minor), 3-O-methylasemone (minor), 5,7-dichlorolichexanthone (minor), 2,4,5-trichlorolichexanthone (minor), 4,5,7-trichlorolichexanthone (minor), 2,5-dichlorolichexanthone (trace).

Distribution and Ecology — At present this species is only known from the holotype specimen which was found growing on the trunk of an unidentified tree.

COMMENTS — As the specimen described above lacks apothecia, we have based its generic identity primarily on the morphology of the campylidia and the medullary chemistry. The campylidia and crustose thallus indicate that this species could belong to the *Ectolechiaceae*. Although the campylidia do not agree exactly with any of the types reported by Sérusiaux (1986), they appear very similar to those of the genus *Sporopodium* Mont. em. R. Sant. Furthermore,

chlorinated xanthenes are common in this genus (Elix et al. 1992, 1995). Up to the present time at least 12 species have been included in this genus (Elix et al. 1995, Lücking et al. 2000, Lücking & Santesson 2002, Santesson 1952), and although all are epiphyllous, many genera are now known to comprise both epiphyllous and corticolous species (Kalb & Vězda 1987). Molecular studies or apothecia (if found), will ultimately reveal more definitive information about the relationships of this taxon.

Acknowledgements

We are greatly indebted to Dr. Alan Fryday (MSC), for the loan of specimens and for information, to Prof. P. M. Jørgensen (Bergen) for information on *Fuscopannaria* and for correcting the Latin diagnoses, and to Mr. J. Berge (Bergen), for photographic assistance. We thank Dr Alan W. Archer and Dr Patrick M. McCarthy and the editors for helpful amendments to the draft manuscript.

Literature cited

- Breuss O. 1999. On some pyrenocarpous lichens from the West Indies. *Linzer biologische Beiträge* 31: 839-844.
- Elix JA, Ernst-Russell KD. 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances (2nd ed.). Australian National University, Canberra.
- Elix JA, Crook CE, Lumbsch HT. 1992. The chemistry of foliicolous lichens 1. Constituents of *Sporopodium vezdeanum* and *S. xantholeucum*. *Mycotaxon* 44: 409-415.
- Elix JA, Giralto M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1-7.
- Elix JA, Lumbsch HT, Lücking R. 1995. The chemistry of foliicolous lichens 2. Constituents of some *Byssoloma* and *Sporopodium* species. *Bibliotheca Lichenologica* 58: 81-96.
- Guderley R. 1999. Die *Lecanora subfusca*-Gruppe in Süd- und Mittelamerika. *Journal of the Hattori Botanical Laboratory* 87: 131-257.
- Imshaug HA. 1957. Catalogue of West Indian lichens. *Bulletin of the Institute of Jamaica Science Series* 6: 1-153.
- Jørgensen PM. 2004. More, new Asian species of the lichen genus *Fuscopannaria*. *Lichenologist* 36: 207-212.
- Jørgensen PM, Sipman H. 2006. The lichen family *Pannariaceae* in the montane regions of New Guinea. *Journal of the Hattori Botanical Laboratory* 100: 695-720.
- Kalb K, Vězda A. 1987. Einige nicht-foliicole Arten der Familie *Ectolechiaceae* (Lichenes) aus Brasilien. *Folia Geobotanica et Phytotaxonomica* 22: 287-312.
- Lücking R, Santesson R. 2002. On the identity of *Pyrenotrichum 'atrocyaneum'*, *P. 'mirum'* and *P. 'podosphaera'*, campylidia of lichenized *Ascomycota* (Lecanorales: Ectolechiaceae). *Bryologist* 105: 57-62.
- Lücking R, Farkas E, Sérusiaux E, Sipman HJM. 2000. Checklist of foliicolous lichens and their lichenicolous fungi. Part 1: Folicolous lichens (extended version) <http://www.uni-bayreuth.de/departments/planta2/ass/robert/lichens/checkfol.html> (last updated 31 October 2000).
- Lumbsch HT. 1994. Die *Lecanora subfusca*-Gruppe in Australasien. *Journal of the Hattori Botanical Laboratory* 77: 1-175.

- Santesson R. 1952. Follicolous Lichens I. A revision of the taxonomy of the obligately foliicolous, lichenized fungi. *Symbolae Botanicae Upsalienses* 12: 1-589.
- Sérusiaux E. 1986. The nature and origin of campylidia in lichenized fungi. *Lichenologist* 18: 1-35.
- Vainio E. 1896. Lichenes Antillarum A.W. Elliott collecti. *Journal of Botany* 34: 1-38.

Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Abortiporus*, *Bondarzewia*, *Grifola*, *Heterobasidion*, *Laetiporus* and *Meripilus*

L.F. GRAND AND C.S. VERNIA

larry_grand@ncsu.edu

*Department of Plant Pathology, North Carolina State University
Raleigh, North Carolina 27695-7616 USA*

Abstract—Distribution and host plants are provided for two species of *Abortiporus*, three species of *Laetiporus* and one species each of *Bondarzewia*, *Grifola*, *Heterobasidion* and *Meripilus*. County distribution maps are provided for each species as well. A complete checklist can be found at: www.mycotaxon.com/resources/weblists.html.

Keywords—fungus distribution, polypores

Introduction

The importance of biodiversity and biogeography of fungi in ecosystems was addressed in previous studies by Grand & Vernia (2004a). Previous studies of poroid wood decay fungi in North Carolina have reported the occurrence of selected genera and host plants (Jung 1987, Vernia & Grand 2000, Grand & Vernia 2002, 2003, 2004a, b, 2005a, b). These studies have greatly expanded the range and host plant reports of many species of poroid wood decay fungi in the southern region of the United States. This report is the fifth in a continuation of a long-term study of poroid wood decay fungi in North Carolina.

Materials and methods

Poroid wood decay fungi were intensively collected in North Carolina from 1997–2006. Data from other studies (Jung 1987, Grand et al. 1975), collections in the Mycological Herbarium (NCSC), North Carolina State University, and records of the Plant Disease and Insect Clinic, Plant Pathology Department, North Carolina State University, were used in developing distribution maps. Other sources for distribution and host plant data are noted in the species checklist.

Collections were obtained for all species of *Abortiporus*, *Laetiporus*, *Bondarzewia*, *Grifola*, *Heterobasidion*, and *Meripilus* on unusual hosts. Specimens were placed in paper bags in the field with a sample of decayed wood with most collections and field notes for all collections. Specimens were examined in the laboratory and identified using existing

taxonomic treatments (Gilbertson & Ryvarden 1986, 1987; Larsen & Lombard 1988; Overholts 1953). Nomenclature and authorities are from Gilbertson & Ryvarden (1986, 1987) and IPNI (2006) for fungi and Kartesz & Kartesz (1980) or IPNI (2006) for host plants.

The majority of collection sites were in state parks, game lands and natural areas, Nantahala, Pisgah, Croatan and Uwharrie National Forests and the Blue Ridge Parkway and Great Smoky Mountains National Parks. A county distribution map is provided for each species (Figs. 1–9).

Results and discussion

Abortiporus biennis (Bull. : Fr.) Singer (Fig. 1) and *A. fractipes* (Berk. & M.A. Curtis) Gilb. & Ryvarden (Fig. 2) appear to be widespread in North Carolina. Collections of both species were made in the Mountain, Piedmont and Coastal Plain provinces. Both species were associated with deciduous tree species plant debris. *Abortiporus biennis* was observed to fruit abundantly on recently dead trees but basidiocarps occurred infrequently after three to four years. *Abortiporus fractipes* was found most frequently on dead branches, often buried in soil, in flood plains.

Bondarzewia berkeleyi (Fr.) Bondartsev & Singer (Fig. 3) was found in the mountains although several collections were made in Wake Co., a Piedmont site. Except for *Prunus pennsylvanica*, all collections of *B. berkeleyi* were at the base of living trees in the genus *Quercus*.

Heterobasidion annosum (Fr. : Fr.) Bref. (Fig. 5) is widespread in North Carolina and was recorded in all three physiographic provinces. *Heterobasidion annosum* is represented by numerous records primarily because it causes an economically important root rot (Woodward et al. 1998).

Meripilus sumstinei (Murrill) M.J. Larsen & Lombard (Fig. 9) was collected in mountain and Piedmont sites. All collections were made at the base of large, still living, oak species.

Three species of *Laetiporus* were found or reported in North Carolina. Early reports (Grand et al. 1975) and herbarium collections (NCSC) that were identified as *L. sulphureus* (Bull. : Fr.) Murrill undoubtedly included *L. cincinnatus* (Morgan) Burds. et al., *L. persicinus* (Berk. & M.A. Curtis) Gilb. and *L. huroniensis* Burds. & Banik. Burdsall & Banik (2001) provided evidence for a species concept in the genus and recognized six species and one variety. Following their study, *L. cincinnatus* (Fig. 6), *L. persicinus* (Fig. 7) and *L. sulphureus* (Fig. 8) were identified. A specimen from Graham County on *Tsuga canadensis* is identified as *L. sulphureus* in the present study but is almost certainly *L. huroniensis*. This collection was on an old, large-diameter, fallen hemlock and fits the description by Burdsall & Banik (2001). *Laetiporus* species in North Carolina need to be studied further to account for their distribution.

Grifola frondosa (Dicks. : Fr.) Gray (Fig. 4) was not collected frequently enough to determine a distributional trend.



Fig. 1. Distribution of *Abortiporus biennis* in North Carolina.

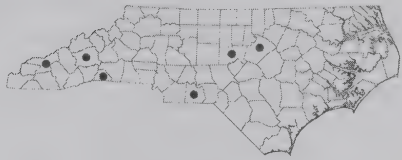


Fig. 2. Distribution of *Abortiporus fraxipies* in North Carolina.

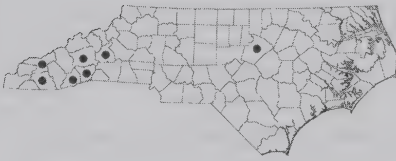


Fig. 3. Distribution of *Bondarzewia berkeleyi* in North Carolina.

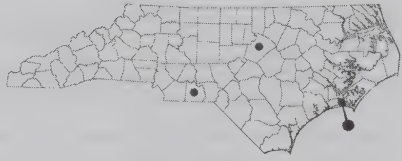


Fig. 4. Distribution of *Grifola frondosa* in North Carolina.

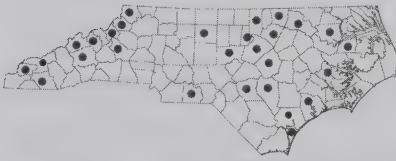


Fig. 5. Distribution of *Heterobasidion annosum* in North Carolina.



Fig. 6. Distribution of *Laetiporus cincinnatus* in North Carolina.

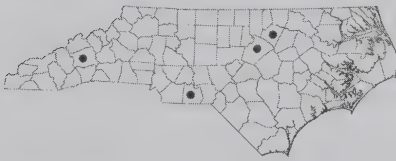


Fig. 7. Distribution of *Laetiporus persicinus* in North Carolina.

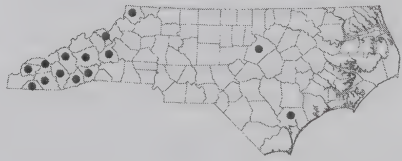


Fig. 8. Distribution of *Laetiporus sulphureus* in North Carolina.



Fig. 9. Distribution of *Meripilus sumstinei* in North Carolina.

Acknowledgements

The authors thank Drs. Richard Baird and Lauraine Hawkins for their suggestions and comments that improved the manuscript and M.J. Munster for aid in the preparation of the manuscript. Financial support for this project was provided, in part, by generous grants from the Highlands Biological Station (Highlands, NC). A special thanks to Tom Howard and the staff of the North Carolina State Parks system for permission to collect in the parks and natural areas of North Carolina. Richard Giles provided additional collections.

Literature Cited

- Burdsall HH Jr, Banik MT. 2001. The genus *Laetiporus* in North America. *Harvard Papers in Botany*. 6:43–55.
- Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol. 1 *Abortiporus* – *Lindtneria*. Fungiflora, Oslo. Pp. 1–433.
- Gilbertson RL, Ryvarden L. 1987. North American Polypores. Vol. 2 *Megasporoporia* – *Wrightoporia*. Fungiflora, Oslo. Pp. 437–885.
- Grand LF, Menge JA, Bond JJ. 1975. Partial checklist of fungi from Highlands, North Carolina and vicinity. *J. Elisha Mitchell Sci. Soc.* 91:221–229.
- Grand LF, Vernia CS. 2002. New taxa and hosts of poroid wood-decay fungi in North Carolina. *Castanea*. 67:193–200.
- Grand LF, Vernia CS. 2003. Noteworthy Collections, North Carolina, *Cryptoporus volvatus* (Peck) Shear. *Castanea*. 68:88–89.
- Grand LF, Vernia CS. 2004a. Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Phellinus* and *Schizopora*. *Mycotaxon*. 89:181–184.
- Grand LF, Vernia CS. 2004b. Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Ceriporia*, *Ceriporiopsis* and *Perenniporia*. *Mycotaxon*. 90:307–310.
- Grand LF, Vernia CS. 2005a. Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Coltricia*, *Coltriciella* and *Inonotus*. *Mycotaxon*. 91:35–38.
- Grand LF, Vernia CS. 2005b. Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Fomes*, *Fomitopsis*, *Fomitella* and *Ganoderma*. *Mycotaxon* 94:231–234.
- IPNI. 2006. The International Plant Names Index. Published on the Internet <http://www.ipni.org> [accessed 15 December 2006].
- Jung HS. 1987. Wood-rotting *Aphyllphorales* of the southern Appalachian spruce-fir forest. *Bibl. Mycol.* 119:1–260.
- Kartesz JT, Kartesz R. 1980. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. University of North Carolina Press, Chapel Hill. 688 pp.
- Larsen MJ, Lombard FF. 1988. The status of *Meripilus giganteus* (*Aphyllphorales*, *Polyporaceae*) in North America. *Mycologia* 80:612–621.
- Overholts LO. 1953. The *Polyporaceae* of the United States, Alaska and Canada. University of Michigan Press, Ann Arbor. 466 pp.
- Vernia CS, Grand LF. 2000. Polypores of a North Carolina Piedmont forest. *Mycotaxon*. 74: 153–159.
- Woodward S, Stenlid J, Karjalainen R, Hutterman A, (eds.). 1998. *Heterobasidion annosum*: Biology, ecology, impact and control. CAB International, Wallingford, UK. 589 pp.

The *Cladoniaceae* of Navarino Island (Prov. Antártica Chilena, Chile)

ANA ROSA BURGAZ* & JOSÉ RAGGIO**

arburgaz@bio.ucm.es

*Departamento de Biología Vegetal I, Facultad de Biología, José Antonio Novais 2
Universidad Complutense de Madrid, 28040-Madrid, Spain

**Departamento de Biología Vegetal II, Facultad de Farmacia, Pl. Ramón y Cajal s/n,
Universidad Complutense de Madrid, 28040-Madrid, Spain

Abstract—Forty two taxa of *Cladoniaceae* are reported from Navarino Island, Chile. *Cladonia acuminata* and *C. cryptochlorophaea* are new to Chilean flora, and eighteen taxa are new reports for Navarino Island. The chemical variation of the taxa is reported. New chemotypes in *C. bellidiflora* with fumarprotocetraric, thamnolic and usnic acids, and *C. ustulata* with thamnolic, barbatic and squamatic acids are reported. A phytogeographic distribution pattern of the taxa with data on their habitat and frequency is presented.

Key words—lichens, biogeography, southern South America

Introduction

Navarino Island is a Chilean territory located in Tierra de Fuego, and belongs to the Comuna de Cabo de Hornos in the XII Region, Magallanes and Antártica Chilena. It is the southernmost American territory that has permanent human settlements. In June 2005, it was named Cape Horn Biosphere Reserve as an area of great importance for conservation of natural resources.

The 2900 km² island is situated between 54°45' - 55° 15'S and 69°-67°W. It lies between the Beagle Channel to the north and Nassau Bay to the south close to the Wollaston Islands where Cape Horn is located. The island is made of igneous rocks (gabbros, diorites, hornblendites and granitoids) from the late Mesozoic times, belonging to the Patagonian Batholith, and covered during late Jurassic to early Cretaceous by sedimentary and volcanic rocks (Hervé et al. 1984). It has a rugged topography shaped by volcanism and extreme weather, the highest peak reaching 1118 m above sea level at Cordillera de los Dientes.

At Port Williams, the capital, the mean annual rainfall is 467 mm. The rain is uniformly distributed throughout the year and part of it falls as snow. The annual mean temperature is 6 °C, the warmest month presenting a mean

temperature of 9.6°C (January) and the coldest one 1.9°C (July). Another important climatic factor is the westerly wind blowing all the year, lowering the summer temperatures and increasing the winter temperatures. This wind is the long-distance dispersal vehicle for many organisms in the south of the Southern Hemisphere such as lichens (Muñoz et al. 2004).

The Island has an extraordinary biota. From sea level up to 500-600 m altitude the Magellanic deciduous forest covers the area, almost in pristine condition, and it is constituted by coihue (*Nothofagus betuloides*), lenga (*N. pumilio*) and ñirre (*N. antarctica*). Above timberline the Andean tundra is dominating. It constitutes of pulvinate shrubs of *Bolax gummifer* and *Azorella selago* mixed with the lichens *Pseudocyphellaria freycinetii*, *P. endochrysea* and *Peltigera rufescens*, and the Antarctic lichen tundra at greater altitude with several *Usnea* species, *Cetraria islandica*, and *Thamnolia vermicularis* in a colouring mosaic. In the most humid sites with bad drainage the Tundra sphagnosa with *Sphagnum magellanicum*, *Marsippospermum grandiflorum* and *Empetrum rubrum* occupies vast territories.

The Chilean *Cladoniaceae* have received considerable attention during recent decades (Ahti & Kashiwadani 1984, Galloway 1998, Galloway & Quilhot 1998, Stenroos 1995, Stenroos & Ahti 1990, Stenroos et al. 1992). Other important publications in adjacent areas are those on the Falkland Islands (Stenroos & Ahti 1992), Neotropical territories (Ahti 2000) and the Antarctic and peri-Antarctic regions (Stenroos 1993, Øvstedal & Lewis Smith 2001), and Argentina (Calvelo & Liberatore 2002), which have strong floristic relationships with Navarino Island.

The family *Cladoniaceae* is characterized by a composite thallus of varied morphology with two main structures, primary thallus and podetia, the latter of which are not always present (Stenroos et al. 2002). The aim of this investigation was to extend the previous lichenological knowledge of the *Cladoniaceae* in this Chilean insular region.

Material and methods

The present study is based on about 600 specimens of fresh material collected in January-February 2005 during a Spanish fieldwork expedition. The material studied is deposited in MACB as well as in the Magallanes University, UMAG, Chile. The species were determined by their morphological and chemical characters. The specimens were analysed by thin-layer chromatography (TLC), using a standardized procedure (White & James 1985).

The exact situation and dominant vegetation types of the major localities studied are as follows:

ANTARCTICA CHILENA PROVINCE: Navarino Island: —Caleta Honda, 20 m altitude, 54° 55' 50.2" S, 68° 17' 02.2" W, a very old and moist *Nothofagus betuloides* forest. —Caleta Honda-Caleta Mejillones, 0-10 m altitude, 54° 54' 18.6" S, 68° 07' 00.1" W. *N. pumilio* forest. —Caleta Mejillones, 10 m altitude, 54° 53' 59.4" S, 68° 00' 10.1" W, *N. pumilio* and

N. betuloides forests. —Caleta Pantalón, 10 m altitude, 54° 54' 49.1" S, 67° 50' 51.8" W, sea cliffs with *N. pumilio* forest. —Mladineo Pass, 650 m altitude, peat bogs with *Sphagnum magellanicum*. —Puerto Navarino, 0-50 m altitude, 54° 58' 23.2" S, 67° 40' 59.8" W, *N. betuloides* forest. —Puerto Williams, Ukika valley, 50-160 m altitude, 54° 57' 38.5" S, 67° 37' 49.4" W, *N. betuloides* and *N. pumilio* forests. —Wiew point in the way to La Bandera peak, 280 m altitude, 54° 57' 36" S, 67° 37' 37.5" W, *N. pumilio* forest. —La Bandera peak, 550 m altitude, 54° 57' 38.5" S, 67° 37' 49.4" W, Andean tundra grassland. —Popi forest, 200-300 m, *N. pumilio* forest. —Róbal lake, camp site, 290 m altitude, 54° 58' 23.3" S, 67° 40' 59.9" W, *N. pumilio* forest. —Róbal lake, 420 m altitude, 54° 58' 40.0" S, 67° 41' 24.7" W, *N. betuloides* forest. —Laguna del Salto, Lake of the Waterfall, Róbal valley, 500 m, peat bogs. —Róbal peak at the base, 510 m altitude, 54° 58' 15.3" S, 67° 41' 30.9" W, *N. antarctica* shrubs. —Way to Lum, 400 m altitude, 54° 57' 44.4" S, 68° 05' 40.3" W, peat bogs with *Sphagnum magellanicum*. —Lake down Dientes de Navarino, 600 m altitude, 54° 59' 52.3" S, 67° 41' 50.5" W. —Holguer Islands: Sea shore rocks.

ÚLTIMA ESPERANZA PROVINCE: Puerto Natales: —río Serrano, close to Milodón Cave, 51° 34' 03.8" S, 72° 37' 10.8" W, *N. antarctica* shrubs. —Hacienda Perales, seno Última Esperanza, *N. betuloides* forest.

Results

A total of 40 taxa were identified plus two more taxa have been reported in previous studies. *Cladonia acuminata* and *C. cryptochlorophaea* are new to the Chilean flora, and 18 taxa are new records for Navarino Island. This is a high number of taxa because Stenroos et al. (1992) reported 52 species from the whole Tierra del Fuego, and Stenroos (1995) 58 taxa from Chile, which comprises an area of considerable extension.

In our studies on the chemical variation of the taxa we found a new chemotype with fumarprotocetraric, thamnolic and usnic acids in *Cladonia bellidiflora*, and a new chemotype with thamnolic, barbatic and squamatic acids in *C. ustulata*. Our indication of frequency with the terms common, scattered and rare is primarily based on the number of specimens recorded but also our field observations.

Taxonomy

* = species reported as new to Navarino Island, ** = species new to Chile.

* *Cladia aggregata* (Sw.) Nyl.

Chemistry: Thallus Pd–, K–, C–. Barbatic and 4-O-demethylbarbatic acids.

Habitat and distribution: In peat bogs. Scattered. Austral.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Wulaia, 10 m, *Vilches*, MACB 92069. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 92070. Dientes de Navarino, 400-600 m, *Popi*, MACB 92068. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92071.

** *Cladonia acuminata* (Ach.) Norrl.

Chemistry: A chemically variable species in southern South America (Stenroos et al. 1992). Thallus Pd+ yellow, K+ yellow to reddish, C–. Our samples have atranorin, conorstictic and norstictic acids.

Habitat and distribution: On soil. Rare. Bipolar distribution. New to the Chilean flora.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Popi forest, *Vilches*, MACB 92066. Way to Lum, 400 m, *Vilches*, MACB 92067.

Cladonia arbuscula (Wallr.) Flot. subsp. *arbuscula* s. lat.

Chemistry: Thallus Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex, usnic and isousnic acids.

Habitat and distribution: On peat bogs. Rare. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Laguna del Salto, Róbalo valley, 500 m, *Raggio*, MACB 91910.

Cladonia asahinae J.W. Thomson

Chemistry: Thallus Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex, rangiformic and norrangiformic acids.

Habitat and distribution: On humous soil. Scattered at lower altitudes common at higher altitudes. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Navarino, 20 m, *Vilches*, MACB 91979. Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 91980. Way to Lum, 400 m, *Vilches*, MACB 91983. Róbalo lake, 420 m, *Vilches*, MACB 91984. Laguna del Salto, Róbalo valley, 500 m, *Raggio*, MACB 91981. Róbalo peak, 500 m, *Vilches*, MACB 91982. Dientes de Navarino, 900 m, *Vilches*, MACB 91985.

Cladonia bacilliformis (Nyl.) Glück

Chemistry: Thallus Pd-, K-, C-. Barbatic, 4-O-demethylbarbatic and usnic acids.

Habitat and distribution: On rotting wood. Rare. Bipolar, with a boreal distribution in Northern Hemisphere and antiboreal in Southern Hemisphere.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Popi forest, 400 m, *Vilches*, MACB 92065. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92061. Ibidem, Serrano river, *Burgaz* 92139.

Cladonia bellidiflora (Ach.) Schaer.

Chemistry: Thallus Pd+ yellow or Pd+ red, K- or K+ yellow to brownish, C-. A chemically variable species with several chemotypes in the area. I: Fumarprotocetraric acid.

II: Fumarprotocetraric and usnic acids, chemotype found in Antarctic and peri-Antarctic material (Stenroos 1995). III: Fumarprotocetraric, thamnolic and usnic acids, new chemotype. IV: Thamnolic acid.

Habitat and distribution: On soil. Rare at sea level, common at 400-750 m. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: I: Puerto Williams, Róbalo valley, 30 m, *Burgaz*, MACB 92064. II: Dientes de Navarino, 400-600 m, *Popi*, MACB 92062. Róbalo peak, 500 m, *Vilches*, MACB 92059. Ibidem, 750 m, *Raggio*, MACB 92060. III: Popi forest, 400 m, *Vilches*, MACB 92075. Róbalo lake, 420 m, *Vilches*, MACB 92063. IV: Róbalo peak, 500 m, *Vilches*, MACB 92140.

* *Cladonia borealis* S.Stenroos

Chemistry: Thallus Pd-, K-, C-. Barbatic, 4-O-demethylbarbatic and usnic acids.

Habitat and distribution: On humous soil. Common. Bipolar distribution.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Navarino, 20 m, *Vilches*, MACB 92197. Caleta Wulaia, 10 m, *Vilches*, MACB 92054. Caleta Honda, 20 m, *Vilches*, MACB 92196. Popi forest, *Vilches*, MACB 92193. Laguna del Salto, Róbalo valley, 500 m, *Raggio*, MACB 92195. Róbalo peak, 500 m, *Vilches*, MACB 92053. La Bandera peak, 590 m, *Burgaz*, MACB 92052. Róbalo peak, 750 m, *Raggio*, MACB 92194. Dientes de Navarino, 900 m, *Vilches*, MACB 92018. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92019. Ibidem, río Serrano, *Burgaz*, MACB 92020.

***Cladonia carneola* (Fr.) Fr.**

Chemistry: Thallus Pd–, K–, C–. Barbatic, 4-O-demethylbarbatic, usnic, isousnic acids and zeorin.

Habitat and distribution: On rotting wood. Common. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Róbalo valley, *Burgaz*, MACB 92055. Ibidem, Ukika valley, 40–80 m, *Burgaz*, MACB 91933. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 91934. Way to Lum, 400 m, *Vilches*, MACB 91938. Róbalo lake, 420 m, *Vilches*, MACB 92056. Róbalo peak, 500 m, *Vilches*, MACB 91021. Ibidem, 750 m, *Raggio*, MACB 92057. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92022. Ibidem, Río Serrano, *Burgaz*, MACB 91935.

* ***Cladonia cenotea* (Ach.) Schaer.**

Chemistry: Thallus Pd– or Pd+ yellow, K– or K+ yellow, C–. Two chemotypes in the area: I: Squamatic and consquamatic acids. II: Thamnic acid.

Habitat and distribution: On rotting wood. Scattered. Bipolar distribution.

Representative specimens: I: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Mejillones, 30 m, *Burgaz*, MACB 91942. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 91941. Way to Lum, 400 m, *Vilches*, MACB 91940. II: Puerto Williams, Ukika valley, 40–80 m, *Burgaz*, MACB 91943.

* ***Cladonia cervicornis* subsp. *mawsonii* (C.W.Dodge) S.Stenroos & Ahti**

Chemistry: Thallus Pd+ red, K– or K+ brownish, C–. Fumarprotocetraric acid complex.

Habitat and distribution: On soil. Common in open areas between *Nothofagus antarctica* shrubs. Subantarctic and Antarctic endemic.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika valley, 40–80 m, *Burgaz*, MACB 91953. Caleta Mejillones, 20 m, *Vilches*, MACB 92200. Popi forest, *Vilches*, MACB 92201. Dientes de Navarino, 900 m, *Vilches*, MACB 91951. Ibidem, 850 m, *Etayo*, MACB 92199. Way to Lum, 400 m, 26-I-2005, *Vilches*, MACB 91952. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92198.

***Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng.**

Chemistry: Thallus Pd+ red, K–, K+ brownish or K+ yellowish, C–. Atranorin (rare), fumarprotocetraric acid complex and quaeisic acid (rare).

Habitat and distribution: On humous soil. Common. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Róbalo valley, 30 m, *Burgaz*, MACB 92002. Ibidem, Ukika valley, 40–80 m,

Burgaz, MACB 92001. Caleta Mejillones, 30 m, *Burgaz*, MACB 92007. Caleta Honda, 20 m, *Vilches*, MACB 92004. Caleta Pantalón, *Gómez-Bolea*, BCC. Caleta Wulaia, 10 m, *Vilches*, MACB 92008. Róbalo peak, 500 m, *Vilches*, MACB 92003. La Bandera peak, 590 m, *Burgaz*, MACB 92000. Ibidem, 1000 m, *Vilches*, MACB 92012. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92009. Ibidem, Laguna Amarga, *Burgaz*, MACB 92010. Ibidem, río Serrano, *Burgaz*, MACB 92011.

Cladonia cornuta (L.) Hoffm.

Chemistry: Thallus Pd+ red, K- or K+ yellow or K+ brownish, C-. Atranorin (rare), fumarprotocetraric acid complex.

Habitat and distribution: On humous soil. Common in open areas. Subcosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 92204. Caleta Wulaia, 10 m, *Vilches*, MACB 92013. Caleta Mejillones, 30 m, *Burgaz*, MACB 92076. Caleta Honda, *Vilches*, MACB 92202. Way to Lum, 400 m, *Vilches*, MACB 92058. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, *Burgaz*, MACB 92203. Ibidem, río Serrano, *Burgaz*, MACB 92077.

** *Cladonia cryptochlorophaea* Asahina

Chemistry: Thallus Pd- or Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex and cryptochlorophaeic acid.

Habitat and distribution: On humous soil. Rare. Cosmopolitan. New to the Chilean Flora.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Róbalo peak, 500 m, *Vilches*, MACB 91987. Rocky outcrops away La Bandera peak, 1000 m, *Vilches*, MACB 91988.

* *Cladonia farinacea* (Vain.) A.Evans

Chemistry: Thallus Pd+ red, K-, K+ yellow or K+ brownish, C-. Atranorin (inconstant) and fumarprotocetraric acid complex.

Habitat and distribution: On humous soil. Scattered at lower altitudes. Southern South America, eastern North America, East and Central Asia.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 92078. Caleta Wulaia, 10 m, *Vilches*, MACB 92141. Caleta Mejillones, 30 m, *Burgaz*, MACB 92142.

Cladonia fimbriata (L.) Fr.

Chemistry: Thallus Pd+ red, K-, K+ yellow or K+ brownish, C-. Atranorin (inconstant), fumarprotocetraric acid complex and quaeisitic acid (rare).

Habitat and distribution: On humous soil. Common. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Ukika village, Puerto Williams, 10 m, *Burgaz*, MACB 91959. Ibidem, Ukika valley, 40-80 m, *Burgaz*, MACB 91958. Caleta Honda, 20 m, *Vilches*, MACB 91957. Caleta Wulaia, 30 m, *Vilches*, MACB 91989. Popi forest, *Vilches*, MACB 92144. View point in the way to La Bandera peak, 295 m, *Burgaz*, MACB 91991. Way to Lum, 300 m, *Vilches*, MACB 91990. Róbalo lake, 420 m, *Vilches*, MACB 91960. Dientes de Navarino, 400-600 m, *Popi*, MACB 92143. Róbalo peak, 750 m, *Raggio*, MACB 92145. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92206.

* *Cladonia furcata* (Huds.) Schrad.

Chemistry: Thallus Pd+ red, K–, K+ yellow or K+ brownish, C–. Fumarprotocetraric acid complex.

Habitat and distribution: On humous soil. Rare. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Róbaló peak, 500 m, *Vilches*, MACB 91986.

Cladonia gracilis (L.) Willd. subsp. *gracilis*

Chemistry: Thallus Pd+ red, K–, K+ yellow or K+ brownish, C–. Atranorin (rare), fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On soil and peat bogs. Common. Bipolar distribution.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika valley, 40–80 m, on soil, *Burgaz*, MACB 91963. Canal Murray, 30 m, *Izaguirre & Suberbiola*, MACB 91962. Way to Lum, 400 m, on peat bogs, *Vilches*, MACB 91964. Róbaló lake, 420 m, *Vilches*, MACB 92205. Dientes de Navarino, 400–600 m, *Popi*, MACB 92146. *Holguer Islands*: on sea shore rocks, *Izaguirre & Suberbiola*, MACB 91961.

Cladonia gracilis subsp. *elongata* (Wulfen) Vain.

Chemistry: Thallus Pd+ red, K–, K+ yellow or K+ brownish, C–. Atranorin (rare), fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On humous soil. Common at higher altitudes. Subcosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: La Bandera peak, 590 m, *Burgaz*, MACB 92149. Way to Lum, 400 m, on peat bogs, *Vilches*, MACB 92150. Dientes de Navarino, 400–600 m, *Popi*, MACB 92147. Róbaló lake, 420 m, *Vilches*, MACB 92148. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, Última Esperanza, 50 m, *Burgaz*, MACB 92151. Ibidem, Serrano river, *Burgaz*, MACB 92152.

* *Cladonia humilis* (With.) J.R.Laundon

Chemistry: Thallus Pd+ red, K– or K+ brownish, C–. Only the chemotype with fumarprotocetraric acid complex and bourgeanic acid was found.

Habitat and distribution: On soil and open areas. Rare. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Navarino, 20 m, *Vilches*, MACB 92024. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92023.

Cladonia laevigata (Vain.) Gyeln.

Chemistry: Thallus Pd+ red, K– or K+ brownish, C–. Fumarprotocetraric acid complex and usnic (rarely absent) acid (Stenroos et al. 1992).

Habitat and distribution: A rare Subantarctic endemic reported by Stenroos et al. (1992), growing in peat bogs at middle altitudes in Navarino Island. Not found.

Cladonia lepidophora Ahti & Kashiw.

Chemistry: Thallus Pd+ red, K–, K+ yellow or K+ brownish, C–. A chemically variable species with three chemotypes in the area. I: Squamatic, consquamatic and usnic

acids, it is the most common chemotype. II: Fumarprotocetraric acid complex, usnic and quaesitic acids. III: Fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On soil. Common. Austral.

Representative specimens: ANTARCTICA CHILENA PROVINCE: I: Navarino Island: Caleta Pantalón, Gómez-Bolea, BBC. Puerto Navarino, 20 m, *Vilches*, MACB 92046. Caleta Honda, 20 m, *Vilches*, MACB 91945. Popi forest, Guanaco valley, 400 m, *Vilches*, MACB 91946 TLC 31. *Holguer Islands*: on sea shore rocks, Izaguirre & Suberbiola, MACB 92025. II: Navarino Island: Caleta Honda, 20 m, *Vilches*, MACB 92050. Laguna del Salto, Róballo valley, 500 m, *Raggio*, MACB 92026. III: Navarino Island: Caleta Honda, 20 m, *Vilches*, MACB 92047.

Cladonia luteoalba Wheld. & A. Wilson

Chemistry: Thallus Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex, usnic and quaesitic acids.

Habitat and distribution: On rotting wood. Rare. Subcosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Dientes de Navarino, 400-600 m, 19-I-2005, *Popi*, MACB 92051.

* *Cladonia macilenta* Hoffm.

Chemistry: Thallus Pd- or Pd+ yellow, K- or K+ yellow, C-. There are two chemotypes in the area. I: Barbatic, 4-O-demethylbarbatic acids. II: Thamnicolic and barbatic acids.

Habitat and distribution: On rotting wood. Scattered. Cosmopolitan.

Representative specimens: I: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 91973. Popi forest, 400 m, *Vilches*, MACB 92048. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Serrano river, *Burgaz*, MACB 92049. II: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Wulaia, 10 m, *Vilches*, MACB 91944. Wiew point in the way to La Bandera peak, 295 m, *Burgaz*, MACB 92079.

* *Cladonia macrophyllodes* Nyl.

Chemistry: Thallus Pd+ red, K+ yellow, C-. Atranorin, fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On rocky outcrops. Rare. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Dientes de Navarino, 400-600 m, *Popi*, MACB 92014.

Cladonia mitis Sandst.

Chemistry: Thallus Pd-, K-, C-. Rangiformic, norrangiformic, usnic and isousnic acids.

Habitat and distribution: On peat bogs and soil. Common. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Róballo valley, 30 m, *Burgaz*, MACB 91912. Puerto Navarino, 20 m, *Vilches*, MACB 91914. Way to Lum, 400 m, *Vilches*, MACB 91915. Bosque Popi, 400 m, *Vilches*, MACB 92074. Róballo lake, 420 m, *Vilches*, MACB 92073. Róballo peak, 500 m, *Vilches*, MACB 91911. Dientes de Navarino, 400-600 m, *Popi*, MACB 92072. *Holguer Islands*: on sea shore rocks, Izaguirre & Suberbiola, MACB 91913.

* *Cladonia novochlorophaea* (Sipman) Brodo & Ahti

Chemistry: Thallus Pd- or Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex, sekikaic and homosekikaic acids.

Habitat and distribution: On peat bogs. Rare. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Way to Lum, 400 m, *Vilches*, MACB 92015.

Cladonia ochrochlora Flörke

Chemistry: Thallus Pd+ red, K-, K+ yellow or K+ brownish, C-. Atranorin (rare), fumarprotocetraric acid complex and quaesitic acid (rare).

Habitat and distribution: On rotting wood. Common. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika village, 10 m, *Burgaz*, MACB 91993. Ibidem, Ukika valley, 40-80 m, *Burgaz*, MACB 91994. Caleta Wulaia, 10 m, *Burgaz*, MACB 91999. Wiew point in the way to La Bandera peak, 295 m, *Burgaz*, MACB 91992. Way to Lum, 300 m, *Vilches*, MACB 91998. Róbalo lake, 420 m, *Vilches*, MACB 91997. Róbalo peak, 500 m, *Vilches*, MACB 91996. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Serrano river, *Burgaz*, MACB 92207.

* *Cladonia phyllophora* Hoffm.

Chemistry: Thallus Pd+ red, K-, K+ yellow or K+ brownish, C-. Atranorin (rare), fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On soil. Rare. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Róbalo peak, 500 m, *Vilches*, MACB 92042. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, Última Esperanza, 50 m, *Burgaz*, MACB 91972.

* *Cladonia pleurota* (Flörke) Schaer.

Chemistry: Thallus Pd-, K-, C-. Usnic, isousnic acids and zeorin.

Habitat and distribution: On humous soil. Rare at sea level but scattered at middle altitude. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Wulaia, 10 m, *Vilches*, MACB 91948. Way to Lum, 400 m, *Vilches*, MACB 92044. Popi forest, Guanaco valley, 400 m, *Vilches*, MACB 92045. Róbalo lake, 420 m, *Vilches*, MACB 92219. Róbalo peak, 500 m, *Vilches*, MACB 92043. Mladineo Pass, 650 m, *Vilches*, MACB 91947.

* *Cladonia pocillum* (Ach.) Grognot

Chemistry: Thallus Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex and quaesitic acid (rare).

Habitat and distribution: On soil and dry peat bogs. Rare. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Mejillones, 30 m, *Burgaz*, MACB 92208. Way to Lum, 400 m, *Vilches*, MACB 91965. Róbalo peak, 500 m, *Vilches*, MACB 92208. Ibidem, 750 m, *Raggio*, MACB 91966.

* *Cladonia pyxidata* (L.) Hoffm.

Chemistry: Thallus Pd+ red, K- or K+ brownish, C-. Fumarprotocetraric acid complex.

Habitat and distribution: On soil. Scattered. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 91970. Caleta Mejillones, 20 m, *Vilches*, MACB 92210. Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 91969. Popi forest, *Vilches*, MACB 92211. Wiew point in the way to La Bandera peak, 295 m, *Burgaz*, MACB 91968. Rocky outcrops close to La Bandera peak, 1000 m, *Vilches*, MACB 91971. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92027.

***Cladonia rangiferina* (L.) F.H.Wigg.**

Chemistry: Thallus Pd+ red, K+ yellow, C-. Atranorin, fumarprotocetraric acid complex.

Habitat and distribution: In peat bogs and tundra scrubs. Common. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Mejillones, 20 m, *Vilches*, MACB 91920. Caleta Honda, 20 m, *Vilches*, MACB 92155. Popi forest, *Vilches*, MACB 92156. Róbalo lake, 420 m, *Vilches*, MACB 92154. Róbalo peak, 500 m, *Vilches*, MACB 91917. Ibidem, 750 m, *Raggio*, MACB 91921. Blue Lake, 575 m, *Vilches*, MACB 91918. La Bandera peak, 590 m, *Burgaz*, MACB 92153. Dientes de Navarino, 400-600 m, *Popi*, MACB 92083. Mladineo Pass, 650 m, *Vilches*, MACB 92084. Way to Lum, peat bogs, 400 m, *Vilches*, MACB 92085. Holguer Islands: on sea shore rocks, *Izaguirre* & *Suberbiola*, MACB 91919. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 91922.

***Cladonia rigida* (J.D. Hooker & Taylor) Hampe**

Chemistry: Thallus Pd+ yellow, K+ yellow, C-. Thamnolic acid (Stenroos at al. 1992).

Habitat and distribution: An austral species, common in Australasia, very rare in South America, reported by Stenroos at al. (1992), growing on rotting wood at lower altitudes in Navarino Island. Not found.

***Cladonia sarmentosa* (Hook.f. & Taylor) C.W.Dodge**

Chemistry: Thallus Pd+ red, K+ yellow or K+ brownish, C-. Atranorin, fumarprotocetraric acid complex and quaeitic acid.

Habitat and distribution: On humous soil. Rare. Austral element.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Mladineo Pass, 650 m, *Vilches*, MACB 92041.

*** *Cladonia scabriuscula* (Delise) Nyl.**

Chemistry: Thallus Pd+ red, K-, K+ yellow or K+ brownish, C-. Atranorin (rare) and fumarprotocetraric acid complex.

Habitat and distribution: On soil. Scattered. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Honda, 20 m, *Vilches*, MACB 91976. Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 91975. Popi forest, 400 m, *Vilches*, MACB 91977. Way to Lum, 400 m, *Vilches*, MACB 92212. Róbalo peak, 500 m, *Vilches*, MACB 92157. La Bandera peak, 590 m, *Burgaz*, MACB 91974.

Cladonia squamosa (Scop.) Hoffm.

Chemistry: Pd– or Pd+ yellow, K– or K+ yellow. There are two chemotypes. I: Squamatic acid. II: Thamnolic acid. The second chemotype was considered as var. *subsquamosa* but there are not morphological variations to distinguish it. This chemotype is the commonest in the Island.

Habitat and distribution: Humous soil. Scattered. Subcosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: I: Navarino Island: Caleta Honda, 20 m, *Vilches*, MACB 91924. Way to Lum, peat bogs, 400 m, *Vilches*, MACB 91925. Holguer Islands: on sea shore rocks, *Izaguirre & Suberbiola*, MACB 91923. II: Navarino Island: Caleta Wulaia, 10 m, *Vilches*, MACB 91932. Róbal lake, 420 m, *Vilches*, MACB 91928. Róbal peak, 500 m, *Vilches*, MACB 91926. Dientes de Navarino, 400–600 m, *Popi*, MACB 92039. Mladineo Pass, 650 m, *Vilches*, MACB 91930.

* *Cladonia subchordalis* A.Evans

Chemistry: Thallus Pd–, K–, C–. Usnic and isousnic acids.

Habitat and distribution: On soil. Rare. South American endemic.

Representative specimens: ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92028. Ibidem, río Serrano, *Burgaz*, MACB 92040.

Cladonia subsubulata Nyl.

Chemistry: Thallus Pd+ yellow, K+ yellow, C–. Thamnolic acid.

Habitat and distribution: On humous soil. Rare. Austral.

Our samples have brownish white podetia and the lower parts are not blue-blackened.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Caleta Mejillones, 30 m, *Burgaz*, MACB 92138.

* *Cladonia subulata* (L.) F.H.Wigg.

Chemistry: Thallus Pd+ red, K– or K+ brownish, C–. Fumarprotocetraric acid complex and quaesitic acid.

Habitat and distribution: On soil. Scattered. Cosmopolitan.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Puerto Williams, Ukika village, 10 m, *Burgaz*, MACB 92218. Ibidem, Ukika valley, 40–80 m, *Burgaz*, MACB 92215. Caleta Wulaia, 10 m, *Vilches*, MACB 92081. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 92158. Caleta Honda, 20 m, *Vilches*, MACB 92217. Way to Lum, 300 m, *Vilches*, Róbal lake, 420 m, *Vilches*, MACB 92080.

Cladonia sulphurina (Michx.) Fr.

Chemistry: Thallus Pd–, K–, C–. Squamatic, consquamatic and usnic acids.

Habitat and distribution: On rotting wood. Scattered. Bipolar.

Representative specimens: ANTARCTICA CHILENA PROVINCE: Navarino Island: Calta Wulaia to Puerto Inútil, *Vilches*, MACB 92213. Puerto Williams, Ukika valley, 40–80 m, *Burgaz*, MACB 92038. Way to Lum, 400 m, *Vilches*, Róbal lake, 420 m, *Vilches*, MACB 91949. Róbal peak, 500 m, *Vilches*, MACB 92036. Dientes de Navarino, 400–600 m, *Popi*, MACB 92037. La Bandera peak, 590 m, *Burgaz*, MACB 92034. Mladineo Pass, 650 m, *Vilches*, MACB 92035.

***Cladonia symphycarpa* (Flörke) Fr.**

Chemistry: Thallus Pd+ yellow, K+ yellow, C-. Atranorin, psoromic and consporomic acids.

Habitat and distribution: On soil. Rare. Northern Hemisphere and southern South America.

Representative specimens: ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Hacienda Perales, 50 m, *Burgaz*, MACB 92016. Laguna Amarga, *Burgaz*, MACB 92017.

***Cladonia ustulata* (Hook.f. & Taylor) Leight.**

Chemistry: Thallus Pd- or Pd+ yellow, K- or K+ yellow, C-. There are three major chemotypes. I: Thamnolic, $\pm$ usnic acids. II: Squamatic, $\pm$ barbatic acids. III: Thamnolic, $\pm$ barbatic and squamatic acids, a new chemotype.

Habitat and distribution: On rotting wood. Common. Austral.

Representative specimens: ANTARCTICA CHILENA PROVINCE: I: Navarino Island: Caleta Honda, 20 m, *Vilches*, MACB 91905. Puerto Williams, Ukika valley, 40-80 m, *Burgaz*, MACB 91901. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 92082. Wiew point in the way to La Bandera peak, 295 m, *Burgaz*, MACB 92029. Way to Lum, 300 m, *Vilches*, MACB 91902. Ibidem, 400 m, *Vilches*, MACB 91900. Popi forest, 400 m, *Vilches*, MACB 91906. Róbal lake, 420 m, *Vilches*, MACB 92031. Róbal peak, 500 m, *Vilches*, MACB 92030. II: Navarino Island: Puerto Williams, Ukika village, 10 m, *Burgaz*, MACB 91909. Ibidem, Ukika valley, 40-80 m, *Burgaz*, MACB 91907. Caleta Wulaia, 10 m, *Vilches*, MACB 91899. Caleta Wulaia to Puerto Inútil, *Vilches*, MACB 91898. Popi forest, 400 m, *Vilches*, MACB 91903. Dientes de Navarino, 400-600 m, *Popi*, MACB 91904. ÚLTIMA ESPERANZA PROVINCE: Puerto Natales, Río Serrano, *Burgaz*, MACB 91908. ANTARCTICA CHILENA PROVINCE: III: Navarino Island: Popi forest, *Vilches*, MACB 92033.

Discussion

The *Cladoniaceae* are widely distributed in the studied territory. Nevertheless, affinities of the taxa to different habitats are found. A small number of species are restricted to sea level (alt. 10-80 m): *Cladonia farinacea*, *C. humilis*, *C. subsubulata* and *C. symphycarpa*. Many only grow above timberline (alt. over 600 m): *Cladonia acuminata*, *C. arbuscula*, *C. cryptochlorophaea*, *C. furcata*, *C. luteoalba*, *C. macrophyllodes*, *C. novochlorophaea*, and *C. sarmentosa*. Most of the species grow in various forest habitats (alt. 10-600 m): *Cladia aggregata*, *Cladonia bacilliformis*, *C. cenotea*, *C. cornuta*, *C. gracilis*, *C. lepidophora*, *C. macilenta*, *C. mitis*, *C. ochrochlora*, *C. phyllophora*, *C. pleurota*, *C. rangiferina*, *C. scabriuscula*, *C. squamosa*, *C. subulata*, *C. sulphurina* and *C. ustulata*. Species with the widest altitudinal range, from sea level to 700-900 m altitude, are: *Cladonia asahinae*, *C. bellidiflora*, *C. borealis*, *C. carneola*, *C. cervicornis* subsp. *mawsonii*, *C. chlorophaea*, *C. fimbriata*, *C. pocillum* and *C. pyxidata*.

A phytogeographic study of the taxa indicates that widespread species dominate. Most are cosmopolitan or subcosmopolitan (17 taxa, 41%) and bipolar (15 taxa, 37%) while the austral element only comprise a 22% (9 taxa); among the latter group it is important to indicate the existence of two

subantarctic endemic taxa and one southern South American endemic taxa.

Altogether 36% (15 taxa) of the species are common and abundant. These are *Cladonia asahinae*, *C. bellidiflora*, *C. borealis*, *C. carneola*, *C. cenotea*, *C. cervicornis* subsp. *mawsonii*, *C. chlorophaea*, *C. cornuta*, *C. fimbriata*, *C. gracilis*, *C. gracilis* subsp. *elongata*, *C. lepidophora*, *C. mitis*, *C. ochrochlora*, *C. rangiferina* and *C. ustulata*. 40% (17 taxa) are considered rare, viz. *Cladonia acuminata*, *C. arbuscula*, *C. bacilliformis*, *C. cryptochlorophaea*, *C. furcata*, *C. humilis*, *C. laevigata*, *C. luteoalba*, *C. macrophyllodes*, *C. novochlorophaea*, *C. phyllophora*, *C. pocillum*, *C. rigida*, *C. sarmentosa*, *C. subchordalis*, *C. subsubulata* and *C. symphylicarpa*. The remaining 24% (10 taxa) are species with a scattered occurrence, such as: *Cladia aggregata*, *Cladonia cenotea*, *C. farinacea*, *C. macilenta*, *C. pleurota*, *C. pyxidata*, *C. scabriuscula*, *C. squamosa*, *C. subulata* and *C. sulphurina*.

Acknowledgements

We thank Francisca Massardo and Ricardo Rozi of Fundación Omora, Eduardo Barrios Governor of Antártica and Tierra de Fuego Province, and Popi the local guide. The authors received financial support from Dr. L. G. Sancho, Facultad de Farmacia (Madrid) and the ANTEX project, also A. R. Burgaz from the Spanish project CGL2004-04795-C04-01. We are grateful to R. Vilches who collected several specimens, Prof. T. Ahti for his generous help and advice, and S. Stenroos and T. Ahti for the scientific review of the manuscript.

Bibliography

- Ahti T. 2000. *Cladoniaceae*. Flora Neotropica Monograph 78: 1-362. New York Botanical Garden: Bronx.
- Ahti T, Kashiwadani H. 1984. The lichen genera *Cladia*, *Cladina* and *Cladonia* in Southern Chile. In: Inoue H (ed.), Studies on cryptogams in Southern Chile: 125-149. Kensheisha: Tokyo (Japan).
- Calvelo S, Liberatore S. 2002. Catálogo de los líquenes de la Argentina. Kurtziana 29(2): 7-170.
- Hervé M, Suárez M, Puig A. 1984. The Patagonian Batholith S of Tierra del Fuego, Chile: timing and tectonic implications. Journal of the Geological Society 141 (5): 909-917.
- Galloway D. 1998. The lichens of Chile: present knowledge and future prospects. In: Marcelli MP, Seaward MRD (eds.): Lichenology in Latin America: History, Current Knowledge and Applications: 87-100. CETESB. Companhia de Tecnologia de Saneamento Ambiental, Estado de Sao Paulo, Sao Paulo, Brazil.
- Galloway DJ, Quilhot W. 1998. Checklist of Chilean lichen-forming and lichenicolous fungi. Gayana Botánica 55: 111-185.
- Muñoz J, Felicísimo AM, Cabezas F, Burgaz AR, Martínez I. 2004. Wind as a long- distance dispersal vehicle in the Southern Hemisphere. Science 304: 1144-1146.
- Øvstedal DO, Lewis Smith RI. 2001. Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. University Press: Cambridge (United Kingdom).
- Stenroos S. 1993. Taxonomy and distribution of the lichen family *Cladoniaceae* in the Antarctic and peri-Antarctic regions. Cryptogamic Botany 3: 310-344.

- Stenroos S. 1995. *Cladoniaceae* (*Lecanorales*, lichenized *Ascomycotina*) in the flora of Chile. *Gayana Botánica* 52: 89-131.
- Stenroos S, Ahti T. 1990. The lichen family *Cladoniaceae* in Tierra del Fuego: problematic or otherwise noteworthy taxa. *Annales Botanici Fennici* 27: 317-327.
- Stenroos S, Ahti T. 1992. The lichen family *Cladoniaceae* in the Falkland Islands. *Annales Botanici Fennici* 29: 67-73.
- Stenroos S, Ferraro LI, Ahti T. 1992. Lichenes *Lecanorales: Cladoniaceae*. In Guarrera SA, Gamundí I, Matteri CM (eds.), *Flora Criptogámica de Tierra del Fuego* 13(7): 1-111. Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires.
- Stenroos S, Myllys L, Hyvönen J. 2002. Phylogenetic hypotheses: *Cladoniaceae*, *Stereocaulaceae*, *Baeomycetaceae*, and *Icmadophilaceae* revisited. *Mycological Progress* 1: 267-282.
- White J, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bulletin of the British Lichen Society* 57: 1-41.

***Cercospora habenariicola* sp. nov. and some new records of cercosporoid fungi from Thailand**

JAMJAN MEEBOON¹, IMAN HIDAYAT¹,
CHIHARU NAKASHIMA² & CHAIWAT TO-ANUN¹

jamjanm@yahoo.com

¹Department of Plant Pathology, Chiang Mai University
Chiang Mai, Thailand

²Graduate School of Bioresources, Mie University
Kurima-Machiya 1577, Tsu 514-8507, Japan

Abstract — Several cercosporoid hyphomycetes were found during field examinations in northern Thailand, including the new species *Cercospora habenariicola* as well as *Passalora atrides*, *P. centrosematis* and *Pseudocercospora cupheae*, which are new to Thailand.

Key words — leaf spots, plant pathogenic fungi, taxonomy.

Introduction

Since the introduction of *Cercospora* by Fresenius (1863), the number of species assigned to this genus increased to more than 5,500 (Crous & Braun 2003). Most of the species are known to be plant pathogens causing leaf spots or leaf blight. The genus was divided into several segregate genera based on criteria mainly introduced by Deighton (1967, 1971, 1973, 1974, 1976, 1979, 1983, 1987), including the structure of conidiomata, conidiophores, conidiogenous cells and conidia. Recently Crous & Braun (2003) altered the concept and circumscription of cercosporoid genera, based on molecular sequence analyses and a reassessment of morphological characters. However, little is known about the species of *Cercospora* and allied genera in Thailand. Sontirat et al. (1980) enumerated 22 species, while Petcharat & Kanjanamaneesathian (1989) reported 48 species of *Cercospora* from southern Thailand, based on the previous criteria of *Cercospora* sensu lato. The present work was initiated to reveal the diversity of *Cercospora* and allied genera in Thailand, and to re-describe the previously known species according to the current taxonomic concepts of cercosporoid hyphomycetes.

In November 2004, September 2005 and November 2005, the Queen Sirikit Botanic Garden (QSBG) in the Chiang Mai Province of northern Thailand was scrutinized with regard to cercosporoid fungi. Four cercosporoid hyphomycetes were found, including one new species and three species new to Thailand.

Materials and methods

Specimens were collected after observing symptoms of cercosporoid fungi on leaves using a 10× magnifying glass. Detailed observations of morphological characters were carried out by means of an Olympus CX31 light microscope using oil immersion (1000×).

Specimens for microscopic observation were prepared by hand sectioning. Water and lactophenol were used as mounting media. Thirty conidia, hila, conidiophores, conidiogenous loci and 10 stromata were measured for each specimen. Line drawings were prepared at a magnification of 400×. Dried herbarium specimens were deposited at CMU Herbarium, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand.

Results

A new species of *Cercospora*

Cercospora habenariicola Meeboon, Hidayat & C. Nakash. sp. nov.

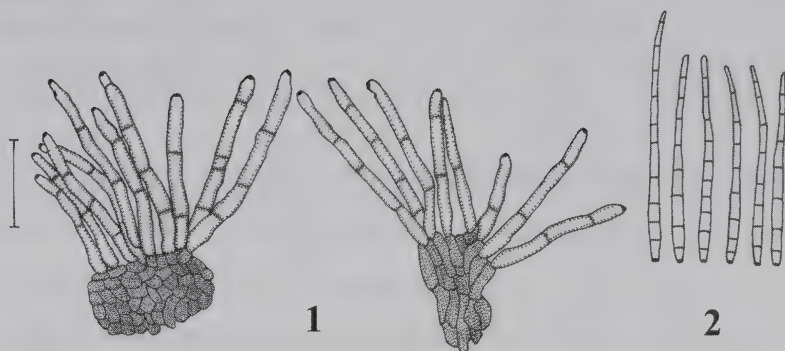
MYCOBANK #: MB 510367

Figs. 1-2

Maculae amphigenae, circulares vel subcirculares, 15-30 mm diam., primo pallide viridulae, ochraceae, deinde brunneae vel atro-brunneae, ultimo centro griseo-brunneo, margine fusco vel brunneo cinctae. Coloniae amphigenae, ochraceae, velutinae. Stromata substomatata vel intraepidermalia, subglobosa, 25-75 µm diam., brunnea vel atro-brunnea. Conidiophora laxa vel dense fasciculata, numerosa, simplicia, raro ramosa, recta, subcylindrica, geniculata vel sinuosa, erecta vel decumbentia, 50-285 × 7.3-7.5 µm, interdum ad 952 µm longa, laevia, pallide olivacea vel pallide brunnea, 2-9-septata. Cellulae conidiogenae integratae, terminales, sympodiales. Loci conidiogeni conspicui, incrassati, fuscati, 2.4-3.6 µm diam. Conidia solitaria, obclavata vel subaciculares, recta, 75-110 × 4.9-5 µm, hyalina, 6-10-septata, laevia, apice subacuto, basi obconice truncata, hila incrassata et fuscata, 1.2-2.9 µm diam.

Etymology — *habenariicola*, from the genus name of the host plant.

Leaf spots amphigenous, circular or subcircular, 15-30 mm diam., at first pale greenish to ochraceous, later brown to dark brown, finally with grayish brown centre, surrounded by a dark margin or brown halo. Colonies amphigenous, ochre yellow, velvety. *Stromata* intraepidermal, well-developed, subglobose, brown to blackish brown, 25-75 µm diam. *Conidiophores* loosely to densely fasciculate, numerous, arising from stromata, simple, straight, rarely branched, subcylindrical, geniculate to sinuous, erect to decumbent, 50-285 × 7.3-7.5 µm, occasionally up to 952 µm long, smooth, pale yellow to pale brown, 2-9-septate. *Conidiogenous cell* integrated, terminal, sympodially proliferating.



Figs. 1-2. *Cercospora habenariicola* sp. nov. 1. Stromata and conidiophores. 2. Conidia.
(Scale bar = 40 μ m).

Conidiogenous loci conspicuous, thickened, darkened, 2.4-3.6 μ m diam. *Conidia* solitary, narrowly obclavate to subacicular, straight, 75-110 $\times$ 4.9-5 μ m, hyaline, 6-10-septate, smooth, apex subacute, base obconically truncate, hilum thickened and darkened, 1.2-2.9 μ m diam.

Specimen examined — On leaves of *Habenaria susannae* (L.) R. Br. (Orchidaceae), Queen Sirikit Botanic Garden, Chiang Mai Province, Thailand, 14 July 2006, Jamjan Meeboon (JM 155) (CMU 27883: Holotype).

Comments — Because of pigmented conidiophores, thickened and darkened conidiogenous loci, hyaline scolecoïd conidia, the new species on *Habenaria susannae* belongs in *Cercospora* s. str. (Crous & Braun 2003). It is easily distinguishable from the plurivorous *C. apii* s. lat. by having well-developed stromata and obclavate conidia with obconically truncate bases (Crous & Braun 2003).

On orchids numerous species of *Cercospora* s. lat. are known, including *C. cyripedii* Ellis & Dearn., *C. dendrobii* H.C. Burnett, *C. odontoglossi* Prill. & Delacr. and *C. peristeriae* H.C. Burnett, which have been excluded and reallocated to the genus *Pseudocercospora* Speg. (Crous & Braun 2003). *Cercospora angraeci* Feuilleaub. & Roum., described from orchids, is an insufficiently known species of unclear generic affinity (Crous & Braun 2003), but based on the original description *C. habenariicola* differs from *C. angraeci* in having much longer, occasionally branched conidiophores (Chupp, 1954). *Cercospora cephalantherae* Ondřej & Závřel, a genuine species of *Cercospora* s. str., is characterized by having very short, narrow conidiophores (10-25 $\times$ 3.5 μ m) and relatively short, narrow conidia [40-80(100) $\times$ 2-3(3.5) μ m] (Ondřej & Závřel 1971). *Cercospora habenariicola* is morphologically fairly very close to *C. epipactidis* C. Massal. However, the latter species has consistently

unbranched, small conidiophores ($10\text{--}45 \times 4\text{--}6\text{ }\mu\text{m}$), and short, narrow conidia [$30\text{--}130 \times 3.5\text{--}5\text{ }\mu\text{m}$] (Chupp 1954). *Cercospora eulophiae* M.S. Patil is another cercosporoid fungus on an orchid (*Eulophia* sp.), but this species was described having straight to flexuous, smaller conidiophores, and pigmented conidia [$75\text{--}250 \times 3.2\text{--}4\text{ }\mu\text{m}$] (Patil 1978).

New *Passalora* and *Pseudocercospora* records from Thailand

Passalora atrides (Syd. & P. Syd.) Y.L. Guo, Fung. Sci. 17: 27, 2002.

≡ *Cercospora atrides* Syd. & P. Syd., Ann. Mycol. 20: 65, 1922.

≡ *Cercosporidium atrides* (Syd. & P. Syd.) Goh & W.H. Hsieh, in Hsieh & Goh, *Cercospora* and similar fungi from Taiwan: 115. 1990.

≡ *Passalora atrides* (Syd. & P. Syd.) Poonam Srivast., J. Living World 1: 112. 1994 (nom. inval.).

Specimen examined — On leaves of *Bridelia ovata* Decne. (*Euphorbiaceae*), Queen Sirikit Botanic Garden, Chiang Mai Province, Thailand, 18 November 2005, Jamjan Meeboon (JM 054) (CMU 27881).

Hosts and distribution — *Bridelia balansae* Tutcher, *B. micrantha* Baill., *B. monoica* Merr., *B. ovata* (*Euphorbiaceae*), China, Sierra Leone, Taiwan (Crous & Braun 2003, Guo & Liu 2003), Thailand.

Comments — *Pseudocercospora aberrans* (Petr.) Deighton (Deighton 1987) is another cercosporoid hyphomycetes recorded on *Bridelia* spp. However, the present specimen was identified as *Passalora atrides*, based on pigmented, ellipsoid-ovoid conidia and conspicuous, thickened, darkened conidiogenous loci.

Passalora centrosematis N. Pons, U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 114. 2003.

≡ *Cercospora centrosematis* Chupp & A.S. Mull., Bol. Soc. Venez. Ci. Nat. 8: 40. 1942 (nom. inval.).

Specimen examined — On leaves of *Centrosema pubescens* Benth. (*Fabaceae*), Queen Sirikit Botanic Garden, Chiang Mai Province, Thailand, 21 November 2004, Jamjan Meeboon (JM 065) (CMU 27882).

Hosts and distribution — *Centrosema pubescens*, *C. virginianum* (L.) Benth., *Centrosema* sp. (*Fabaceae*), Philippines, Puerto Rico and Venezuela (Crous & Braun 2003), Thailand.

Comments — This is the first record of this species from Thailand.

Pseudocercospora cupheae (Syd.) U. Braun, Schlechtendalia 2: 14. 1999.

≡ *Cercospora cupheae* Syd., Ann. Mycol. 37: 428. 1939.

Specimen examined — On leaves of *Cuphea hyssopifolia* Kunth, Queen Sirikit Botanic Garden, Chiang Mai Province, Thailand, 21 November 2004, Jamjan Meeboon (JM 074) (CMU 27884).

Hosts and distribution — *Cuphea hyssopifolia*, *C. parsonsia* R. Br. ex Steud., *C. strigulosa* Kunth (*Lythraceae*), Dominican Republic, Ecuador, Mexico (Crous & Braun 2003), Thailand.

Comments — This is the first record of *Cuphea hyssopifolia* as host of *Pseudocercospora cupheae*.

Acknowledgments

This work was financially supported, in part, by a Grant-in-Aid from the Hitachi Scholarship Foundation and the Thailand Research Fund (PDF/47/2542). The authors thank Prof. Dr. Uwe Braun and Dr. Eric McKenzie for reviewing the manuscript. Dr. James F. Maxwell is also thanked for identification the host plants.

Literature cited

- Braun U. 1999. Taxonomic notes on some species of the *Cercospora* complex (V). *Schlechtendalia* 2: 1-28.
- Chupp C. 1954. A monograph of the fungus genus *Cercospora*. Published by the author, Ithaca, New York.
- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series 1.
- Deighton FC. 1967. Studies on *Cercospora* and allied genera II. *Passalora*, *Cercosporidium* and some species of *Fusicladium* on *Euphorbia*. *Mycol. Pap.* 112: 1-80.
- Deighton FC. 1971. Studies on *Cercospora* and allied genera III. *Centrospora*. *Mycol. Pap.* 124: 1-13.
- Deighton FC. 1973. Studies on *Cercospora* and allied genera IV. *Cercosporiella* Sacc., *Pseudocercosporiella* gen. nov. and *Pseudocercosporidium* gen. nov. *Mycol. Pap.* 133: 1-62.
- Deighton FC. 1974. Studies on *Cercospora* and allied genera V. *Mycovellosiella* Rangel, and a new species of *Ramulariopsis*. *Mycol. Pap.* 137: 1-75.
- Deighton FC. 1976. Studies on *Cercospora* and allied genera VI. *Pseudocercospora* Speg., *Pantospora* Cif., and *Cercoseptoria* Petr. *Mycol. Pap.* 140: 1-168.
- Deighton FC. 1979. Studies on *Cercospora* and allied genera VII. New species and redispositions. *Mycol. Pap.* 144: 1-56.
- Deighton FC. 1983. Studies on *Cercospora* and allied genera VIII. Further notes on *Cercoseptoria* and some species and redispositions. *Mycol. Pap.* 151: 1-13.
- Deighton FC. 1987. New species of *Pseudocercospora* and *Mycovellosiella*, and new combinations into *Pseudocercospora* and *Phaeoramularia*. *Trans. Brit. Mycol. Soc.* 88: 365-391.
- Fresenius G. 1863. Beiträge zum Mykologie 3. Brömmel Verlag, Frankfurt.
- Guo YL. 2002. Studies on *Cercospora* and allied genera in China VII. *Fung. Sci.* 17: 27-30.
- Guo YL, Liu XJ, Hsieh W. 2003. Flora fungorum Sinicorum 20: *Mycovellosiella*, *Passalora*, *Phaeoramularia*. Science Press, Beijing. 189p.
- Onďřej M, Zavřel H. 1971. Sběry parazitických imperfektních hub rodu *Cercospora* Fresen. z území CSSR II. Čas. Slez. Mus. Opavě, Ser. A., Hist. Nat., 20: 17-29.
- Patil MS. 1978. Some species of *Cercospora* from Maharashtra-VII. *Indian Phytopathol.* 31: 327-330.
- Petchcharat V, Kanjanamaneeathian M. 1989. Species of plant pathogen *Cercospora* in Southern Thailand. *Thai. Phytopathol.* 9(1): 23-27. (in Thai)
- Sontirat P, Phitakpraiwan P, Choonbamroong W, Kueprakone U. 1980. Plant pathogenic *Cercosporae* in Thailand. Department of Agriculture, Ministry of Agriculture and Cooperative, Bangkok, Thailand. 51 p.

Taxonomic reassessment of two taxa of helotialean fungi

WEN-YING ZHUANG^{1*} & CHAO-YANG LIU^{1, 2}

zhuangwy@sun.im.ac.cn

¹Key Laboratory of Systematic Mycology & Lichenology, Institute of Microbiology
Chinese Academy of Sciences, Beijing 100080 China²School of Life Science and Engineering, Southwest University of Science and Technology
Mianyang 621010 China

Abstract — Species of the genera *Calycina*, *Hymenoscyphus*, *Dicephalospora*, *Lambertella*, *Lanzia*, *Rutstroemia*, *Ciboria*, *Dumontinia*, *Monilinia*, and *Rhizoscyphus* often share a similar ectal excipular structure but differ in many other aspects when morphological features are concerned. A neighbor-joining tree containing the above mentioned genera based on sequence analysis of the ITS regions was established with *Lachnum spartinae* and *L. cf. pygmaeum* as outgroup. Three major clades were recognized. One clade contains most species of *Hymenoscyphus* (except for *Hymenoscyphus rhodoleucus*) as well as *Lanzia microserotina*; the second consists of only the *Ericaceae*-associated genus *Rhizoscyphus*; and the third includes the genera currently treated in the *Sclerotiniaceae* and *Rutstroemiaceae*, as well as two species, *Hymenoscyphus rhodoleucus* and *Calycina herbarum*. *Lanzia microserotina* is not closely related to *Lanzia* spp. but to *Hymenoscyphus serotinus*. *Lanzia huangshanica* f. *aurantiaca* is recognized at species level. New combinations in *Hymenoscyphus* and *Lanzia* are proposed based on the morphological and molecular data. Placement of *Calycina herbarum* and of *Hymenoscyphus rhodoleucus* are noted.

Key words — ITS1-5.8S-ITS2, *Hymenoscyphus microserotinus*, *Lanzia aurantiaca*

Introduction

The type of ectal excipular structure has long been used as an important character in taxonomy of different groups of helotialean cup-fungi (Le Gal 1953, Korf 1973, Spooner 1987). “Textura prismatica” and “textura angularis” are regularly found in the *Helotiaceae*, *Hyaloscyphaceae*, *Leotiaceae*, *Rutstroemiaceae*, and *Sclerotiniaceae*. Members of the genera *Calycina* and *Hymenoscyphus* (*Helotiaceae*), *Dicephalospora*, *Lambertella*, *Lanzia* and *Rutstroemia* (*Rutstroemiaceae*), *Ciboria*, *Dumontinia* and *Monilinia* (*Sclerotiniaceae*), and *Lachnum* (*Hyaloscyphaceae*), as well as *Rhizoscyphus*, often share a similar excipular structure. Other morphological features, such as presence or absence

* Author for correspondence.

Table 1. Material used in this study

Species	Source of the material	Chinese	GenBank Acc no.
<i>Calycina herbarum</i> (Pers.) Gray	1549, HMAS* 77056	Jiangxi	AY348594
<i>Ciboria betulae</i> (Woronin ex Navashin) W.L. White			Z81427
<i>Ciboria caucus</i> (Rebent.) Fuckel			Z73766
<i>Dicephalospora rufocornea</i> (Berk. & Broome) Spoonner	2652, HMAS 75519	Guangdong	DQ986480**
<i>Hymenoscyphus caudatus</i> (P. Karst.) Dennis	1105, HMAS 82057	Anhui	AY348576
	1354, HMAS 82060	Beijing	AY348577
	1459, HMAS 82063	Jiangxi	AY348578
	1578, HMAS 82073	Jiangxi	AY348579
<i>H. epiphyllus</i> (Pers.) Rehm ex Kauffman	1489, HMAS 82075	Jiangxi	AY348580
	1491, HMAS 82076	Jiangxi	AY348581
<i>H. fructigenus</i> (Bull.) Gray			AJ430396
<i>H. cf. fructigenus</i>	2247, HMAS 75877	Sichuan	AY348582
<i>H. fucatus</i> (W. Phillips) Baral & Hengstm.	2178, HMAS 75902	Sichuan	AY348583
<i>H. immutabilis</i> (Fuckel) Dennis	1274, HMAS 71809	Beijing	AY348584
<i>H. lasiopodius</i> (Pat.) Dennis	1221, HMAS 71820	Beijing	AY348585
	1255, HMAS 71821	Beijing	AY348586
	0242, HMAS 75878	Beijing	AY348587
<i>H. cf. menthae</i> (W. Phillips) Baral	0015, HMAS 75934	Sichuan	AY348588
<i>Hymenoscyphus rhodoleucus</i> (Fr.) W. Phillips			AJ430395
<i>H. scutula</i> (Pers.) W. Phillips			
	3546, HMAS 82092	Jilin	AY348589
	3548, HMAS 82093	Jilin	AY348590
<i>H. serotinus</i> (Pers.) W. Phillips	1278, HMAS 82098	Beijing	AY348591
<i>H. globus</i> W.Y. Zhuang & Yan H. Zhang	1544, HMAS 82122	Jiangxi	AY348592
<i>Lachnum cf. pygmaeum</i> (Fr.) Bres.	1558, HMAS 82107	Jiangxi	AY348593
<i>Lachnum spartinae</i> S.A. Cantrell			AJ430215
<i>Lambertella</i> sp.			AF422970
<i>Lanzia huangshanica</i> W.Y. Zhuang & Korf	3176,	Yunnan	AY348595
<i>f. huangshanica</i>	3683, HMAS 81363	Hainan	DQ986483
	3881, HMAS 81364	Hainan	DQ986484
<i>Lanzia huangshanica f. aurantiaca</i> W.Y. Zhuang	1878, HMAS 74836	Guangxi	DQ986485
	1082, HMAS 61850	Anhui	DQ986486
<i>Lanzia microserotina</i> W.Y. Zhuang			
	1142, HMAS 68520	Anhui	DQ986481
<i>Rhizoscyphus ericae</i> (D.J. Read)	1147, HMAS 68521	Anhui	DQ986482
W.Y. Zhuang & Korf			AF069440
<i>Hymenoscyphus</i> sp. G1			AF069505
<i>Rutstroemia bolaris</i> (Batsch) Rehm			AJ292199
<i>Rutstroemia firma</i> (Pers.) P. Karst.			Z80894
			Z80893

* Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences.
** Numbers in boldface indicating the newly submitted sequences.

of sclerotia or substratal stromata, gelatinization of apothecial tissues, color and septation of ascospores, and color of hymenial surface, as well as apothecial gross morphology, are also critical in taxonomy of the helotialean fungi at either generic or species level. In order to weigh the excipular structure and a few other morphological features commonly applied in taxonomy from a

phylogenetic point of view, ITS regions of the above mentioned genera were used to construct a phylogenetic tree. Judging from both morphological and molecular data, the taxonomic positions of a few previously identified inoperculate cup-fungi are reexamined here.

Materials and methods

For morphological and anatomic studies, dried apothecia were rehydrated and sectioned by a freezing microtome at a thickness of 15–20 μm . Measurements were taken from the sections mounted in cotton blue-lactophenol solution and from squash mounts.

For investigation of the taxonomic and phylogenetic positions of the helotialean fungi, total DNAs of taxa in the genera *Dicephalospora* and *Lanzia* (Table 1) were extracted from dried fungal specimens using the protocols of Doyle (1991). The sequences of ITS1-5.8S-ITS2 regions were obtained by using ITS4 and ITS5 as primer pairs (White et al. 1990) and amplified on a GeneAmp PCR System 2400 (Perkin Elmer) using the following parameters: denaturation at 94°C for 4 min., then with 35 cycles of 50 sec at 94°C, 45 sec at 55°C and 1 min 30 sec at 72°C, and a final extension at 72°C for 7 min. PCR products were purified by using the 3S Spin PCR Product Purification Kit (Shenergy Biocolor for Life Science Co., Ltd.), then sequenced by Shanghai Genecore Biotechnologies Co., Ltd. The sequences were aligned together with those of the related fungi from GenBank (Table 1) by Clustal X (Thompson et al. 1994), positions with gaps were treated as missing data, and a neighbor-joining tree was created with *Lachnum* cf. *pygmaeum* and *L. spartinae* as the outgroup and with bootstrap values from 1000 replicates by PAUP 4.0b10 (Swofford 2002).

Results and discussion

Three major clades were recognized in the neighbor-joining tree (Fig. 1). One clade includes mainly genera in the *Sclerotiniaceae* and *Rutstroemiaceae* as well as *Hymenoscyphus rhodoleucus* and *Calycina herbarum*. The second clade consists of only the *Ericaceae*-symbiotic genus *Rhizoscyphus*. The third clade contains most species of *Hymenoscyphus* investigated and *Lanzia microserotina*. Among the helotialean fungi tested in this study, the type of ectal excipular structure did not provide phylogenetic information at the family level, whereas it might be informative at generic and species ranks.

On hymenium color in taxonomy

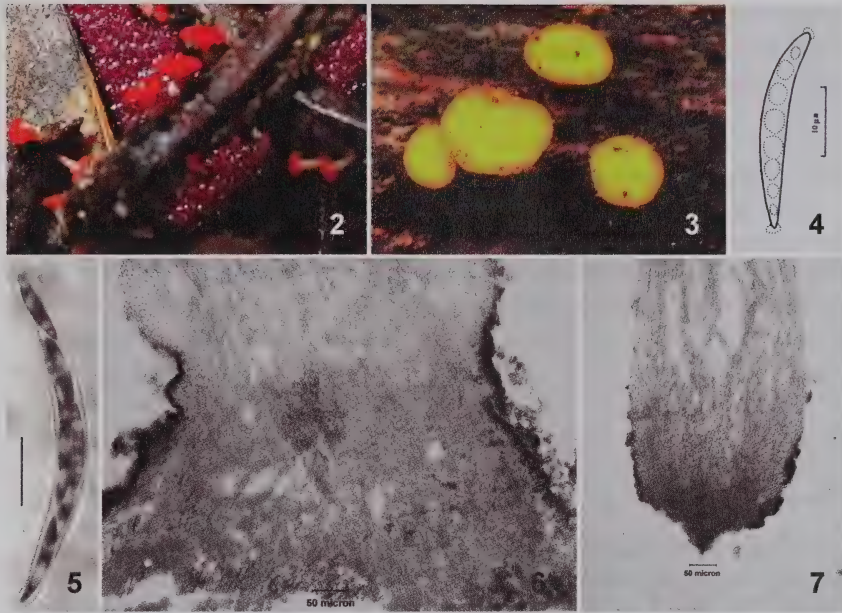
Dicephalospora was established and originally treated as a member of the *Sclerotiniaceae* in a broad sense (Spooner 1987) and one of its species, *D. rufocornea*, is very common throughout the world tropics (Dumont 1980, Zhuang 1998a, b, 1999). Morphologically, *Lanzia huangshanica* and *Dicephalospora*



Fig. 1. Neighbor-joining tree showing phylogenetic relationships of some helotialean cup-fungi inferred from the ITS1-5.8S-ITS2 region, with *Lachnum spartinae* and *L. cf. pygmaeum* as outgroup with bootstrap values from 1000 replicates.

rufocornea share many similarities in the stromatized apothecial stipe base at attachment to substrates (Figs. 2–3, 6–7), excipular structure, ascus iodine reaction, and the fusoid ascospores. However, *D. rufocornea* is characterized by the much longer ascospores with a gel cap at each end and larger apothecia (Spooner 1987, Zhuang 1995a) (Figs. 4–5).

The petiole-inhabiting fungi *Lanzia huangshanica* forma *aurantiaca* and *L. huangshanica* forma *huangshanica* are very similar in apothecial shape, size and anatomy; ascospore shape, size and guttulation; as well as paraphysis shape and width; the former has an orange-yellow hymenial color in fresh condition and the latter has a dark red color. A very slight difference in spore length ($21\text{--}26 \times 4\text{--}4.8 \mu\text{m}$ vs. $18\text{--}26 \times 4\text{--}5 \mu\text{m}$) was also detected. Since intermediate apothecial color was never found within collections, two formae of the same species were distinguished (Zhuang 1995a).



Figs. 2-7. Morphology of *Dicephalospora* and *Lanzia* spp.: 2. Fruitbodies of *Lanzia huangshanica* on nature substrates, HMAS 97515; 3. Fruitbodies of *Dicephalospora rufocornea*, from Wang and Wu (1997); 4. An ascospore of *Dicephalospora rufocornea* with a gel cap at both ends, HMAS 61840; 5. An ascus with ascospores of *Lanzia aurantiaca*, HMAS 61847, bar = 20 μ m; 6. Longitudinal section of *Lanzia huangshanica* showing stromatized (blackened) apothecial stipe base, HMAS 81364; 7. Longitudinal section of *Dicephalospora rufocornea* showing stromatized (blackened) apothecial stipe base, HMAS 81349.

In the current study, a close relationship has been shown between *D. rufocornea* and the two formae of *L. huangshanica*; they formed a separate cluster with 79% bootstrap support (Fig. 1). *Lanzia huangshanica* f. *huangshanica* is more closely related to *D. rufocornea* (with 95% bootstrap value) than to *L. huangshanica* f. *aurantiaca*; and *L. huangshanica* f. *aurantiaca* joins them with 79% bootstrap support (Fig. 1). *Lanzia huangshanica* f. *huangshanica* possesses a dark red hymenium; *D. rufocornea* has an orange red, orange-yellow to dirty yellow one; and *L. huangshanica* f. *aurantiaca* appears purely orange-yellow. Our results suggest that hymenial color, a phenotypic character, carries phylogenetic information. *Lanzia huangshanica* f. *aurantiaca* should stand at species rank instead of as a forma of *L. huangshanica*. A new combination is thus proposed.

***Lanzia aurantiaca* (W.Y. Zhuang) W.Y. Zhuang, stat. & comb. nov.**

MYCOBANK # MB510590

= *Lanzia huangshanica* f. *aurantiaca* W.Y. Zhuang, Mycosystema 7: 14 [1994], 1995.

As mentioned above, hymenial color may carry phylogenetic information in the same genus. Another fungus, *Lanzia phaeoparaphysis* W.Y. Zhuang, having a dirty orange to black hymenium and somewhat smaller ascospores is similar to *L. aurantiaca* and *L. huangshanica* in apothecial size, spore shape, and excipular structure (Zhuang 1995b), and should be closely related. Apothecial color is a useful criterion in taxonomy and phylogeny of certain groups of cup-fungi.

The genus *Dicephalospora* has been accepted as a member of the *Sclerotiniaceae* since its establishment (Spooner 1987, Kirk et al. 2001). From the morphological point of view and results of this study (Fig. 1), the genus should presumably be placed in the *Rutstroemiaceae* (Holst-Jensen et al. 1997). Further work is needed. New questions that need to be answered include: are *Dicephalospora rufocornea*, *Lanzia huangshanica* and their relatives too close to be placed in separate genera? Does the one character, presence of ascospore gel caps, carry phylogenetic information?

Placement of *Lanzia microserotina*

As indicated by our previous study, the correct genus for accommodating *Lanzia serotina* (Pers.) Korf & W.Y. Zhuang should be *Hymenoscyphus* and the correct name of the fungus is *H. serotinus* (Zhang & Zhuang 2004). Another fungus occurring on leaf blades, petioles and herbaceous stems, similar to *H. serotinus* in many aspects, and described as *Lanzia microserotina*, is distinguishable from the former by the reduced sizes in each part of the apothecia, especially the much shorter asci and ascospores (Zhuang 1996). The taxonomic position of *L. microserotina* was re-investigated in this study. Our results indicate that it is very closely related to *H. serotinus* based on both morphological and molecular data. *Lanzia microserotina* resolves among species of *Hymenoscyphus* and groups together with *H. serotinus* with 100 % bootstrap support (Fig. 1). Their excipular structure, ascus shape, and spore shape are very similar (Figs. 8–9). The main reason that they both were considered previously as members of *Lanzia* is their slightly colored apothecial stipe base (Korf & Zhuang 1985, Zhuang 1996), but the apothecia do not arise from stromatized plant tissues. When additional collections were examined, this character became unstable among individuals (Zhuang 1998c), i.e. color change at the stipe base is not always detectable in different collections of the same species. *Lanzia microserotina* is clearly congeneric with *Hymenoscyphus serotinus* and a formal transfer of the fungus to *Hymenoscyphus* is here proposed.

***Hymenoscyphus microserotinus* (W.Y. Zhuang) W.Y. Zhuang, comb. nov.**

MycoBank # MB510596

= *Lanzia microserotina* W.Y. Zhuang, Mycosystema 8–9: 32, 1996.

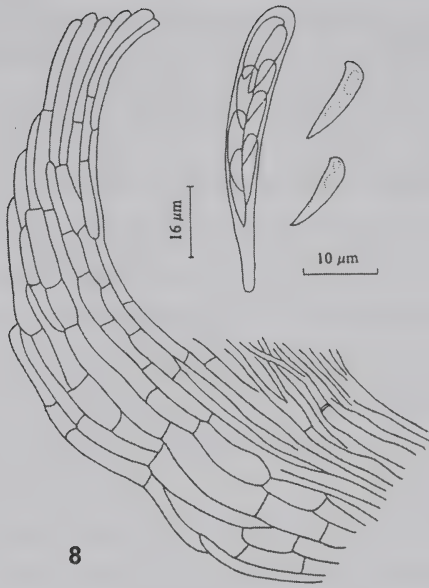


Fig. 8. *Hymenoscyphus microserotinus*: ectal excipular structure, an ascus with ascospores, and two free ascospores, HMAS 71812; from Zhuang (1998c).

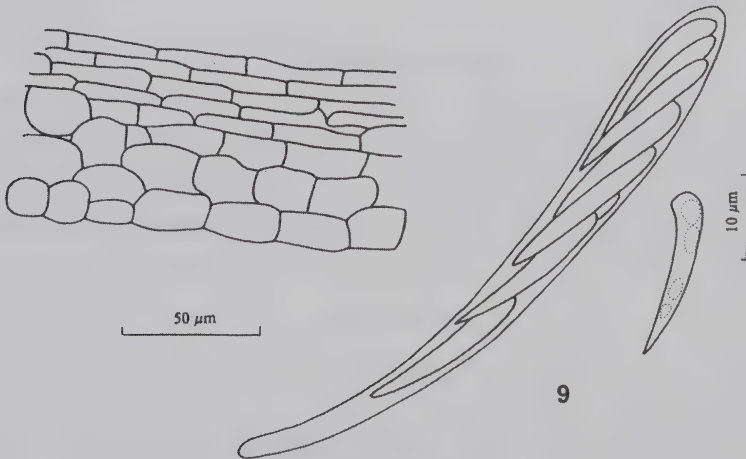


Fig. 9. *Hymenoscyphus serotinus*: ectal excipular structure, an ascus with ascospores, and a free ascospore, HMAS 75941; from Zhuang (1998c).

Placement of *Calycina herbarum* and of *Hymenoscyphus rhodoleucus*

Quite unexpected in our studies was the position of them in our phylogenetic tree (Fig. 1), nestled in the midst of rutstroemiaceous genera. *Calycina herbarum* is a relatively common fungus and widespread on herbaceous stems, while *Hymenoscyphus rhodoleucus* is not as common and appears to be restricted to stems of *Equisetum*. Dennis (1968) and Breitenbach & Kränzlin (1984) provided descriptions and colored illustrations of both fungi. The descriptions of *H. rhodoleucus* by both authors are identical but the illustrations provided are not exactly the same. Breitenbach & Kränzlin (1984) took pictures of the fungus on its natural substrate, which showed clearly darkened areas of host tissues on which apothecia grew. Is the darkened host tissue stromatized? If so, the position of *H. rhodoleucus* in our phylogenetic tree is reasonable, i.e., the species is rutstroemiaceous (Fig. 1). But the color illustration by Dennis (1978) showed that the plant tissue on which apothecia occurred appeared normal in color. If this is the case, position of *H. rhodoleucus* among the rutstroemiaceous fungi remains questionable. *Calycina herbarum* is different. The species is now placed in the genus *Calycina* due to its excipular structure differing from that commonly observed in taxa of *Hymenoscyphus*, but some authors disagree. The descriptions and illustrations of the species by both authors are more or less the same (Dennis 1978, Breitenbach & Kränzlin 1984), as well as what we observed in Chinese material. There is no sign of any stromatized substrates or substratal stromata to which apothecia are attached. Since available sequences of these two species are very limited, future studies need to be undertaken that might explain our results.

Acknowledgements

The authors would like to thank Prof. R. P. Korf, Dr. K. D. Hyde and Dr. J. McNeill for critical review of the manuscript and valuable suggestions, Dr. Y.-Z. Wang for sending photographs of *Dicephalospora rufocornea*, Ms. X. Song for making the sections, Mr. J. Luo for technique help, and Dr. G.-R. Hu for providing specimen information. This project was supported by the National Natural Science Foundation of China (nos. 30230020, 30499340).

Literature cited

- Breitenbach J, Kränzlin F. 1984. Fungi of Switzerland. Vol. 1 *Ascomycetes*. Verlag Mykologia, Luzern.
- Dennis RWG. 1978. British *Ascomycetes*. J. Cramer, Vaduz.
- Doyle J. 1991. DNA protocols for plants. In: Molecular Techniques in Taxonomy. (eds. C. Simon, G.M. Hewitt, A.W.B. Johnston and Young JPW). Springer-Verlag, Berlin: 283-294.
- Dumont KP. 1980. *Sclerotiniaceae* XVI. On *Helotium rufo-corneum* and *Helotium fraternum*. Mycotaxon 12: 255-277.

- Holst-Jensen A, Kohn LM, Schumacher T. 1997. Nuclear rDNA phylogeny of the *Sclerotiniaceae*. *Mycologia* 89: 885-899.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. CAB International, Wallingford.
- Korf RP. 1973. Discomycetes and *Tuberales*. pp. 249-319. In Ainsworth GC, Sparrow FK, Sussman AS (eds.) *The Fungi: An Advanced Treatise*. Vol. 4A. Academic Press. New York & London.
- Korf RP, Zhuang WY. 1985. Some new species and new records of discomycetes in China. *Mycotaxon* 22: 483-514.
- Le Gal M. 1953. Les discomycètes de Madagascar. *Prodr. Flore Mycol. Madagascar Dép.* 4: 1-465.
- Spooner BM. 1987. *Helotiales* of Australasia: *Geoglossaceae*, *Orbiliaceae*, *Sclerotiniaceae*, *Hyaloscyphaceae*. *Biblioth. Mycol.* 116: 1-711.
- Swofford DL. 2002. PAUR* 4.0b10: Phylogenetic Analysis Using Parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.
- Thompson JD, Higgins DG, Gibson TJ. 1994. Clustal W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, positions-specific gap penalties and weight matrix choice. *Nucleic Acids Res.* 22: 4673-4680.
- Wang YZ, Wu ML. 1997. Two species of the *Sclerotiniaceae* in Taiwan. *Fungal Science* 12: 105-108.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. pp. 315-322. In Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds.). *PCR Protocols: A Guide to Methods and Applications*. Academic Press, New York.
- Zhang YH, Zhuang WY. 2004. Phylogenetic relationships of some members in the genus *Hymenoscyphus* (*Ascomycetes*, *Helotiales*). *Nova Hedw.* 78: 475-484.
- Zhuang WY. 1995a. A few petiole-inhabiting discomycetes in China. *Mycosystema* 7: 13-17 [1994].
- Zhuang WY. 1995b. Some new species and new records of discomycetes in China. V. *Mycotaxon* 56: 31-40.
- Zhuang WY. 1996. The genera *Lambertella* and *Lanzia* (*Sclerotiniaceae*) in China. *Mycosystema* 8-9: 15-38 [1995-1996].
- Zhuang WY. 1998a. Discomycetes of tropical China. I. Collections from Hainan Island. *Mycotaxon* 67: 21-31.
- Zhuang WY. 1998b. Discomycetes of tropical China. II. Collections from Yunnan. *Mycotaxon* 69: 339-358.
- Zhuang WY. 1998c. *Flora Fungorum Sinicorum*. Vol. 8. *Sclerotiniaceae et Geoglossaceae*. Science Press, Beijing. (in Chinese)
- Zhuang WY. 1999. Discomycetes of tropical China. IV. More fungi from Guangxi. *Mycotaxon* 72: 325-337.

Taxonomic studies of *Alternaria* from China X. Two new species on *Polygonum*

MENG ZHANG^{1,2} & TIAN-YU ZHANG²

ZM20066@126.com

¹ College of Plant Protection, Henan Agricultural University
Zhengzhou, Henan, China, 450002

² College of Plant Protection, Shandong Agricultural University
Taian, Shandong, China, 271018

Abstract—Two new species of the genus *Alternaria*, *A. polygoni* and *A. dissitiflora*, are reported. They are different from *A. rumicicola* reported on the genus *Rumex* in *Polygonaceae*. Type specimens are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, hyphomycetes, plant pathogens, leaf spots

In the course of a survey of mitosporic fungal pathogens of important weeds, two new taxa of *Alternaria* on *Polygonum* in Xinjiang and Shandong were found. We describe them as follows.

Alternaria polygoni Meng Zhang & T.Y. Zhang, sp. nov.

MYCOBANK # MB510403

FIGURE 1

Maculae orbiculares vel suborbiculares, griseo-brunneae, 2–3mm diam. Ex cultura in agar PCA-charta filtra descripta. Conidiophora solitaria, infusata, erecta, non ramosa, 14.0–60.0 × 3.0–4.5µm. Catenae conidiorum constatae ex conidiis 4–8, recta vel ramulis brevibus. Conidia ovoidea, obpyriforma vel obclavata, medio-brunnea vel brunnea, 4–10 transverse septata, 2–8 longitudinaliter vel oblique septata, constricta ad plures septata, plures septata distincte crassata, atro-brunnea, 19–54 × 10–22µm, av. 39 × 17µm. Pseudorostra pallide infusata vel subhyalina, (0–) 4.5–15 (–32) × 3.5–4.5µm.

Holotype: on leaf spots of *Polygonum*. sp.: Urumqi, Xinjiang Uighur Autonomous Region, 2000, Coll. M. Zhang., HSAUP II₀ 0993 (=ZM II₀ 0593). Dried ex-type cultures on PCA in HSAUP II₀ 0993.

Leaf spots circular or subcircular, greyish brown, 2–3mm in diameter. Colonies on PDA grey to greyish black, velvety, effuse; most conidia becoming chlamydospores. Colonies on PCA grey, velvety, effuse, sporulating sparsely.

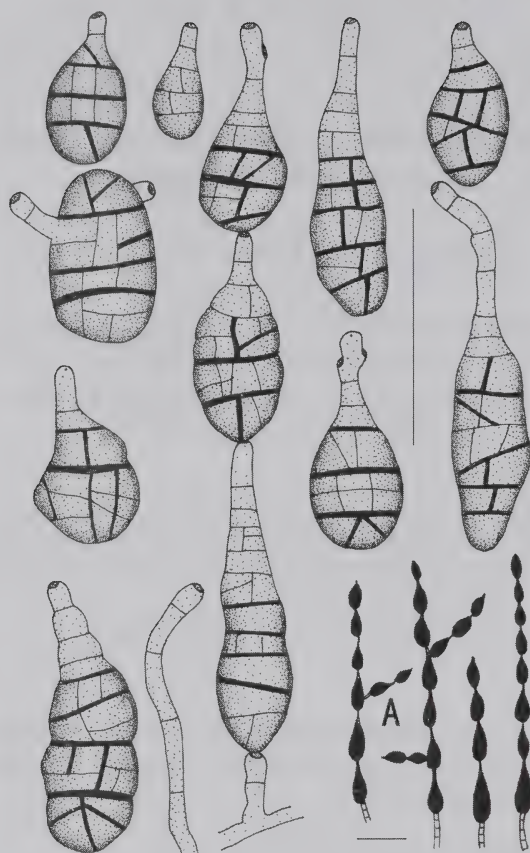


FIGURE1 *Alternaria polygoni*
Conidia, conidiophores and sporulation patterns (A) on PCA + filter paper.
(ex holotype, all bars=50µm)

On PCA + filter paper sporulating freely. Conidiophores arising singly or in groups terminally or laterally from hyphae, simple, straight or curved, smooth-walled, septate, pale brown, paler toward the apex, $14-60 \times 3-4.5\mu\text{m}$. Chains of 4-8 conidia often unbranched or with short branches (1-3 conidia). Conidia ovoid, obpyriform or obclavate, medium brown to brown, smooth-walled, with 4-10 transverse septa and 2-8 longitudinal or oblique septa, some septa are constricted, thicker and darker, $19-54 \times 10-22\mu\text{m}$, av. $39 \times 17\mu\text{m}$. Pseudorostrum straight, apex sometimes geniculate, subhyaline to pale brown, septate, (0-) $4.5-15$ (-32) $\times 3.5-4.5\mu\text{m}$.

Alternaria dissitiflora Meng Zhang & T.Y. Zhang, sp. nov.

FIGURE 2

MYCOBANK # MB510404

Maculae irregularis, pallide brunnea. Ex cultura in agar PCA descripta. Conidiophora solitaria, erecta, simplicia vel ramosa, ad $21\text{--}52 \times 2.5\text{--}3.5\mu\text{m}$. Catenae conidiorum constatae ex conidiis $7\text{--}10$, ramulis brevibus. Conidia obclavata, pallide brunnea, $3\text{--}6$ transverse septata, $0\text{--}2$ longitudinaliter vel oblique septata, constricta ad plures septata, $13\text{--}33 \times 5\text{--}10\mu\text{m}$, av. $21 \times 7\mu\text{m}$. Pseudorostra subhyalina, apica inflata, $2.5\text{--}36 \times 2.5\text{--}4.5\mu\text{m}$.

Holotype: on leaf spots of *Polygonum dissitiflorum* Hemsl.: Taian, Shandong Province, 2003, Coll. M. Zhang., HSAUP₀₃ 0134 (=ZM₀₃ 0134). Dried ex-type cultures on PCA in HSAUP₀₃ 0134.

Leaf spots irregular, pale brown. Colonies on PCA grey, velvety, effuse. Conidiophores arising singly terminally or laterally from hyphae, simple, or branched, straight or curved, smooth-walled, septate, pale brown, paler towards

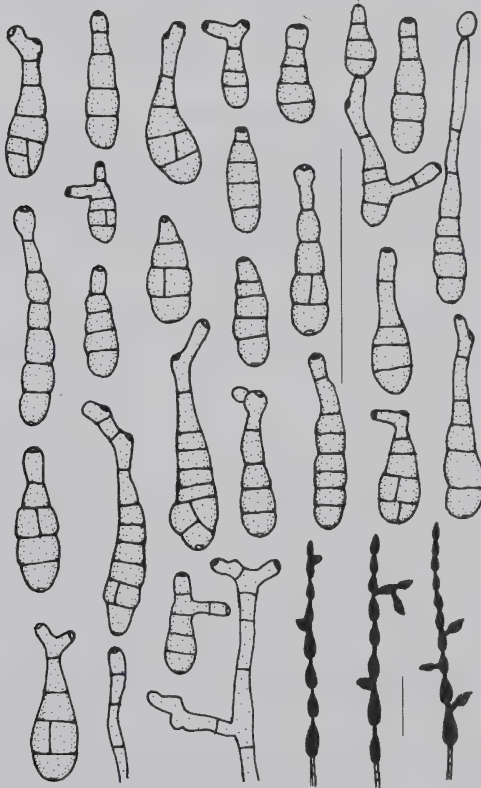


FIGURE 2 *Alternaria dissitiflora*

Conidia, conidiophores on PCA and sporulation patterns on PCA + filter paper.
(ex holotype, all bars= $50\mu\text{m}$)

the apex, $21\text{--}52 \times 2.5\text{--}3.5\mu\text{m}$. Chains of 7–10 conidia often with short branches (1–3 conidia). Conidia obclavate, pale brown, smooth-walled, with 3–6 transepta and 0–2 longitudinal or oblique septa, some septa constricted, $13\text{--}33 \times 5\text{--}10\mu\text{m}$, av. $21 \times 7\mu\text{m}$. Pseudorostra straight, sometimes apex geniculate and inflate, subhyaline to pale brown, septate, $2.5\text{--}36 \times 2.5\text{--}4.5\mu\text{m}$.

Only one *Alternaria* species has been reported on plants of *Polygonaceae* namely *Alternaria rumicicola* R.L. Mathur et al. (with conidia $19\text{--}84 \times 7\text{--}14\mu\text{m}$, av. $49 \times 10.5\mu\text{m}$). The conidia of the two new taxa on *Polygonum* are obviously smaller than the described species and their shape and size are different from each other. The sporulation patterns of the two new species are somewhat close to those of *A. tenuissima* (Kunze) Wiltshire, but they can be easily distinguished by their conidial shape, septation and size.

Acknowledgments

The authors are grateful to Drs. B. Kendrick, Canada and Prof. Y.L. Guo, Institute of Microbiology, Academia Sinica for reviewing the manuscript.

Literature cited

- Mathur RL, Agnihotri VP, Tyagi RNS. 1962. Two undescribed species of *Alternaria*. *Current Science*, 31(7): 296–298.
- Zhang TY, Zhang JZ, Chen WQ, Zhang Meng, Sun GY, Gao MX. 2003. *Flora Fungorum Sinicorum*, 16: *Alternaria*. Beijing: Science Press, 1–283 + Plates.

Taxonomic studies of *Helminthosporium* from China III. Three new species in Guangdong Province

MENG ZHANG ^{1,2} TIAN-YU ZHANG ^{2,*} WEN-PING WU ³

ZM20066@126.com

¹ College of Plant Protection, Henan Agricultural University
Zhengzhou, 450002 China

² College of Plant Protection, Shandong Agricultural University
Taian, 271018 China

³Novozymes China, Beijing 100085 China

Abstract—Three new species of the genus *Helminthosporium* are reported. They are *Helminthosporium multiseptatum*, *Helminthosporium subhyalinum* and *Helminthosporium constrictum*. Type specimens are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, hyphomycetes, saprophytes

In the course of a survey of *Helminthosporium* species in China, three new taxa were found from Guangdong Province. We describe them as follows.

Helminthosporium multiseptatum Meng Zhang, T.Y. Zhang & W.P. Wu, sp. nov.

MYCOBANK MB510407

FIGURE 1

Mycelium immersum. Stromata partim superficialia, partim immersa, atro-brunnea, pseudoparenchymatica, usque ad 20 μ m alta, usque ad 25 μ m lata. Conidiophora singularia, erecta, subcylindrica, recta vel parce flexuosa, septata (cellulis 17–47 μ m longis), levia, brunnea vel atro-brunnea, interdum apicem versus pallidiora, 390–650 μ m longa, basi 10–14 μ m crassa, apice 7–9 μ m crassa, poris conidiiferis ad apicem et infra 1–3 septa supera praedita. Conidia per poros ad apicem conidiophori et lateraliter infra septa supera oriunda, recta vel leviter flexuosa, tenuiter obclavata vel subflagelliformis, levia, pallide brunnea, apicem versus pallidiora, 13–25 (av. 20) pseudoseptata, 78–192 (av. 149) μ m longa, 11–16 (av. 13) μ m crassa, apicem versus ad 3–6 μ m gradatim attenuata, basi cicatrice atra praedita.

On dead branches of unidentified plant, Guangdong Province, China, Coll. Wenping Wu. 9 Oct. 1998, HSAUP 0356 (=WWP 2207), holotype.

Etym.: L., referring to the multiseptate conidia.

**Corresponding author



FIGURE 1 *Helminthosporium multiseptatum* (ex holotype, Bar=50 μ m)

Mycelium immersed in the substratum. Stromata partly superficial, partly immersed, dark brown, pseudoparenchymatous, up to 20 μ m high, 25 μ m wide. Conidiophores arising singly from the upper cells of the stromata, simple, subcylindrical, straight or slightly flexuous, septate, smooth-walled, brown to dark brown, paler towards the apex, 390–650 μ m long, 10–14 μ m wide at the base, 7–9 μ m wide at the apex, with 1–3 well defined, small pores (conidiogenous loci) at the apex and a few formed laterally beneath the upper 1–3 septa. Conidia tretic, arising through pores at the conidiophore apex, and laterally beneath the upper septa, straight or slightly flexuous, thinly obclavate or nearly whip-like, smooth-walled, pale brown, paler toward the apex, 13–25 (av. 20) pseudoseptate, 78–190 (av. 149) μ m long, 11–16 (av. 13) μ m thick in the widest part, narrowing toward the apex to 3–6 μ m, with a dark blackish-brown scar at the base.

The new taxon is close to *Helminthosporium longisinuatum* Matsush. in conidial size, but the conidia of the latter are thinner and S-shaped. The multiseptate, long, thin tapered conidia and tall, slender conidiophores are useful in distinguishing this species from the others in the genus *Helminthosporium*.

Helminthosporium subhyalinum Meng Zhang & T.Y. Zhang, sp. nov.

MYCOBANK MB510408

FIGURE 2

Ex specimine descripta. Mycelium immersum. Stromata absentia. Conidiophora singularia vel fasciculata, erecta, subcylindrica, recta vel flexuosa, septata, levia, brunnea, interdum apicem versus pallidiora, 120–200 μm longa, ad basim ad 10–12 μm inflata, supra basim 6–8.5 crassa, apice interdum inflata, poris conidiiferis 1–3 ad apicem et infra septa supera praedita. Conidia per poros ad apicem conidiophori et lateraliter infra septa supera oriunda, recta vel leviter flexuosa, tenuiter obclavata, levia, maxime pallentia, 6–9 pseudoseptata, 72–125 (av. 100) μm longa, 9.0–11.5 (av. 10.6) μm crassa, apicem versus ad 2.5–5 μm gradatim attenuata, apicem fuscatis, basi cicatrice atra praedita.

Ex culture descripta. Coloniae in agar TWA+W velutinae, griseae vel brunneae, effusae. Conidia absentia. In agar PDA-Charta filtra, sporulantes libere. Mycelium ex hyphis subhyalinis vel brunneis levibus septatis fuscatis 1.5–6.0 μm crassis compositum. Conidia 7–10-pseudoseptata, 54–100 (av. 86) μm longa, 8–10 (av. 8.6) μm crassa, apicem versus ad 2.5–5 μm gradatim attenuata, apicem fuscatis, basi cicatrice atra praedita.

On living leaves of *Phoenix hanceana* Naud., Guangdong Province, China, Coll. Xiu-Guo Zhang, 9 Oct. 1999, HSAUP 991137, holotype.

Etym.: L., referring to the colour of conidia.

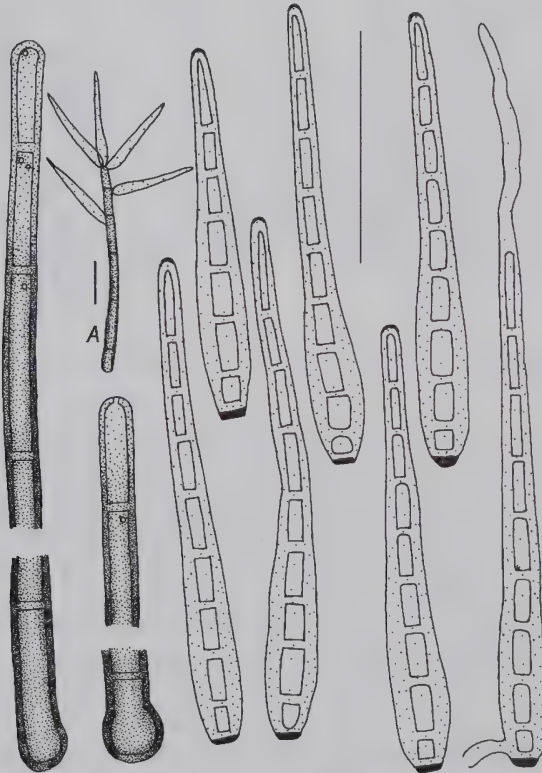


FIGURE 2 *Helminthosporium subhyalinum* (ex holotype, Bar=50 μm), A: Low-power drawing.

Mycelium immersed in the substratum. Stromata not formed. Conidiophores single or in fascicles, simple, subcylindrical, straight or flexuous, septate, smooth-walled, brown, paler towards the apex, 120–200 μm long, 6–8.5 μm wide above the base which is swollen to 10–12 μm wide, sometimes slightly inflated at the tip, with 1–3 well-defined, small pores at the apex and a few formed laterally beneath the upper septa. Conidia tetric, arising through pores at the apex and laterally beneath the upper septa, straight or flexuous, thinly obclavate, smooth-walled, subhyaline, 6–9 pseudoseptate, 72–125 (av. 100) μm long, 9.0–11.5 (av. 10.6) μm thick in the widest part, narrowing towards the apex to 2.5–5 μm , black at the tip, with a dark blackish-brown scar at the base.

Colonies in tap water agar + wheat straw (TWA+W) grey to brown, velvety, effuse, conidia not formed. In PDA-filter paper, sporulating freely. Mycelium subhyaline to brown, septate black, branched, smooth-walled. 1.5–6 μm thick. Conidia straight or flexuous, thinly obclavate, smooth-walled, 7–10-pseudoseptate, 54–100 (av. 86) μm long, 8–10 (av. 8.6) μm thick in the widest part, narrowing towards the apex to 2.5–5 μm , black at the tip, with a dark blackish-brown scar at the base.

In conidium morphology, the new taxon is close to *Helminthosporium chlorophorae* M.B. Ellis and *Helminthosporium kakamegense* Siboe et al. However, *H. chlorophorae* has stromata, the tips of its conidiophores are swollen. The conidia of *H. kakamegense* are obviously smaller. The new taxon can be separated from other species in the genus *Helminthosporium* by its subhyaline, black-tipped conidia. The typically thin-obclavate conidium shape is also very helpful in distinguishing it from other species in the genus with obclavate, obpyriform or ovoid conidia.

***Helminthosporium constrictum* Meng Zhang, T.Y. Zhang & W.P. Wu, sp. nov.**

MYCOBANK MB510409

FIGURE 3

Mycelium immersum. Stromata partim superficialia, partim immersa, atro-brunnea, pseudoparenchymatica, usque ad 12 μm alta, usque ad 34 μm lata. Conidiophora singularia, erecta, subcylindrica, recta vel parce flexuosa, septata (cellulis 13–20 μm longis) levia, brunnea vel atro-brunnea, interdum apicem versus pallidiora, 88–205 μm longa, basi 5.0–8.0 μm crassa, apice 5–7 μm crassa, poris conidiiferis ad apicem et infra 1–3 septa supera praedita. Conidia per poros ad apicem conidiophori et lateraliter infra septa supera oriunda, recta vel leviter flexuosa, obclavata, levia, brunnea, apicem versus pallidiora, 9–15-pseudoseptata, interdum constrictae ad septa, 57–120 (av. 86) μm longa, 9–12 (av. 10) μm crassa, apicem versus ad 2.5–5.0 μm gradatim attenuata, basim truncatum.

On dead branches of *Trachycarpus fortunei* (Hook.) H. Wendl., Dinghushan, Guangdong Province, China, 9 Oct. 1998, leg. Wenping Wu, HSAUP *o*₃₇₄(=WWP 1892b), holotype.

Etym.: L., referring to the constricted septa of conidia.



FIGURE 3 *Helminthosporium constrictum* (ex holotype, Bar=50 µm)

Mycelium immersed in natural substratum. Stromata partly superficial, partly immersed, dark brown, pseudoparenchymatous, up to 12 µm high, 34 µm wide. Conidiophores arising singly from the upper cells of the stromata, simple, subcylindrical, straight or slightly flexuous, septate, smooth-walled, brown to dark brown, paler towards the apex, 88–205 µm long, 5.0–8.0 µm wide at the base, 5–7 µm wide at the apex, with well-defined, small pores at the apex and a few formed laterally beneath the upper 1–3 septa. Conidia tretic, arising through pores at the apex and laterally beneath the upper septa, straight or slightly flexuous, obclavate, smooth-walled, pale brown, paler toward the apex, 9–15-pseudoseptate, sometimes obviously constricted at one or two septa, 57–120 (av. 86) µm long, 9–12 (av. 10) µm thick in the widest part, narrowing toward the apex to 2.5–5 µm, abruptly tapered to a truncate base.

The species closest in conidial morphology to our new taxon is *Helminthosporium dalbergiae* M.B.Ellis. However, the conidia of *H. dalbergiae* are thicker (12–14 μm), have a large dark blackish-brown scar at the base, are not constricted at any septa, and are paler than those of the new species. The conidiophores of *H. dalbergiae* are also larger (300–1300 μm long, 10–15 μm thick).

Acknowledgments

We are grateful to Dr. X.G. Zhang for collecting some specimens and to Mr. Y.M. Wu for inking the drawings. Thanks are also expressed to Drs. B. Kendrick, Canada and Prof. Y.L. Guo, Institute of Microbiology, Academia Sinica for reviewing the manuscript.

Literature Cited

- Ellis MB. 1961. Dematiaceous hyphomycetes III. Mycological Papers 82: 2–39.
Siboe GM, Kirk PM, Cannon PF. 1999. New dematiaceous hyphomycetes from Kenyan rare plants. Mycotaxon 73:283–302.

Taxonomic studies of *Curvularia* from China III. Two new species on *Poaceae*

MENG ZHANG^{1,2} & TIAN-YU ZHANG^{2,*,*}

ZM20066@126.com

¹ College of Plant Protection, Henan Agricultural University
Zhengzhou, China 450002

² College of Plant Protection, Shandong Agricultural University
Taian, China, 271018

Abstract—Two new species of the genus *Curvularia* on *Poaceae* are reported. They are *Curvularia pseudorobusta* and *Curvularia graminis*. Type specimens are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, hyphomycetes, plant pathogens

Introduction

In the course of a survey of *Curvularia* species in China, two taxa on grasses in Beihai, Guangxi Province and Hangzhou, Zhejiang Province were found. They are different from previously reported species of *Curvularia* and we describe them as follows.

Taxonomic description

Curvularia pseudorobusta Meng Zhang & T. Y. Zhang sp. nov.

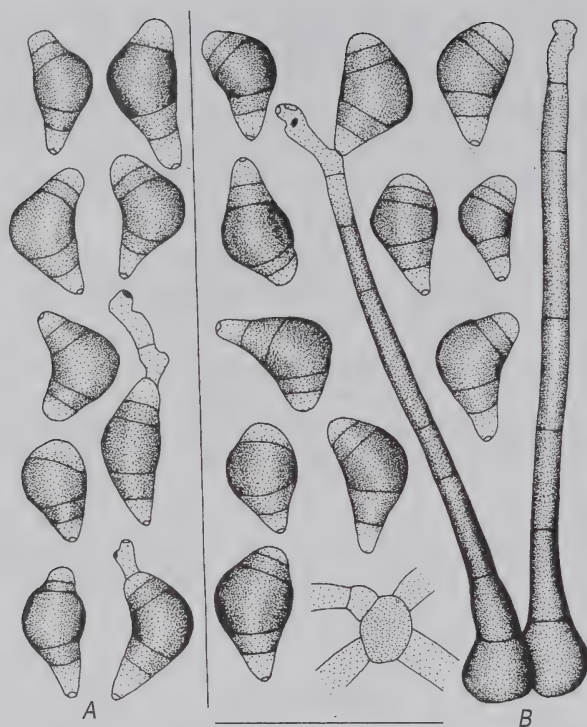
MYCOBANK # MB510414

FIGURE 1

Mycelium in substrato immersum vel partim superficialia, ex hyphis ramosis septatis pallide brunneis levibus vel verruculosis 2–8 μm crassis compositum. Conidiophora ex apice lateribusque hypharum oriunda, singularia vel fasciculata, simplicia, recta vel flexuosa, interdum geniculata, septata, pallide brunnea, apicem versus pallidiora, levia, 100–240 μm longa, cellula basali ad 17 μm inflata, supra basim 7–12 μm crassa, apice 4–5 μm crassa. Conidia acropleurogena, levia, fusiformis vel clavata, gibbosa, inaequilateralia vel curvata, 3–4 (plerumque 4)–septata, cellula media inflata, globosa, brunnea, cellulis extimis pallide brunneis, hilo non protrudenti; in agar TWA+W: 22–33 $\times$ 11–16 μm , av. 27 $\times$ 13 μm , in substrato naturali: 23–31 $\times$ 11–17 μm , av. 26 $\times$ 14 μm .

On living leaves of an undetermined plant in *Poaceae*, Beihai, Guangxi Province, China, coll. Guo–Zhu Zhao, 13 Nov.1999, HSAUP 992347–2, holotype.

^{**}Corresponding author

FIGURE 1 *Curvularia pseudorobusta*

A: Conidia in TWA+W. B: Conidia and conidiophores in natural substratum.
(ex holotype, Bar=50 μ m)

Colonies in tap water agar+wheat straw (TWA+W) grey to greyish brown, cottony, effuse, sporulating freely. Stromata not formed. Mycelium partly immersed in the substratum, pale brown to mid brown, septate, branched, smooth or verruculose, 2–8 μ m thick, sometimes swollen to 12 μ m thick. Conidiophores arising singly or in groups terminally or laterally from hyphae, simple, straight or slightly curved, smooth-walled, apex sometimes geniculate, septate, mid brown, paler toward the apex, on natural substrata 100–240 μ m long, swollen at the basal cell upto 17 μ m thick, 7–12 μ m thick just above the basal swelling, 4–6 μ m thick at the apex, in culture, length variable, 3.5–6 μ m thick, base thinner. Conidia acropleurogenous, typically 4-septate, smooth-walled, broadly fusiform to clavate, gibbous, and inequilateral to strongly curved. The central cell was greatly inflated, nearly globose, apex rounded, basal cell obconic, middle cells brown, the two end cells paler. Some conidia can sporulate secondarily. In natural substratum: 23–31 $\times$ 11–17 μ m, av. 26.5 $\times$ 14.5 μ m, in TWA+W: 22–33 $\times$ 11–16 μ m, av. 27.6 $\times$ 13.5 μ m.

Conidial morphology in *Curvularia pseudorobusta* resembles that in *C. robusta* Kilp. & Luttr., but conidia of *C. robusta* are larger (on natural substratum 39–56×21–27 µm, in culture 25–76×15–26 µm; Kilpatrick & Luttrell 1967). Conidia of *C. pseudorobusta* also resemble those of *C. senegalensis* (Speg.) Subram., but conidia of the latter are narrower (10–14 µm), not as strongly curved, and the central cell not so conspicuously inflated. Conidia of *C. senegalensis* do not produce secondary conidia (Ellis 1966).

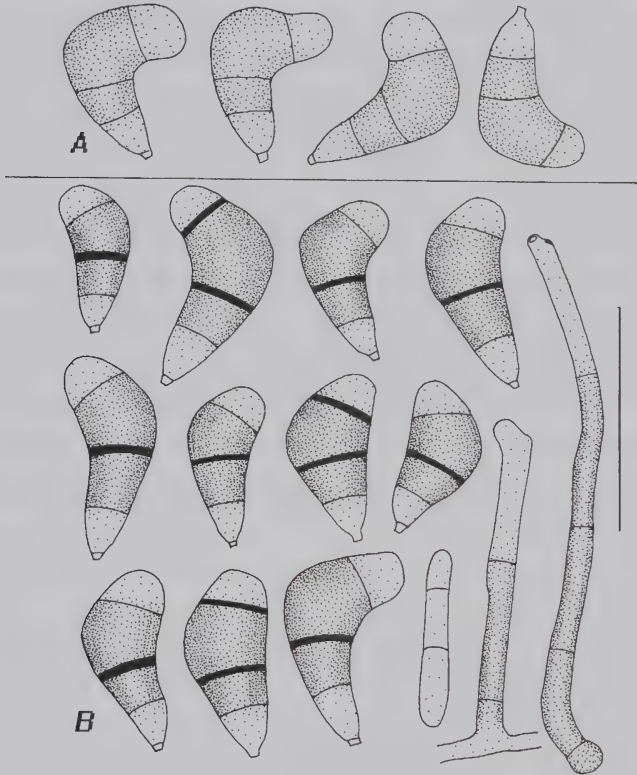


FIGURE 2 *Curvularia graminis*

A: Conidia in TWA+W. B: Conidia and conidiophores in natural substratum.
(ex holotype, Bar=50 µm)

***Curvularia graminis* Meng Zhang & T.Y. Zhang, sp. nov.**

MYCOBANK #MB510415

FIGURE 2

Coloniae in agaro (TWA+W), griseae vel brunneae, effusae, stromata absentia. Sporulantes libere. Mycelium in substrato plerumque immersum, ex hyphis ramosis septatis subhyalinis vel pallide brunneis levibus 1.0–4.5 µm crassis compositum. Conidiophora ex apice lateribusque hypharum oriunda, singularia vel fasciculata, divergentia, simplicia, recta vel flexuosa, interdum geniculata, septata, medio-brunnea, apicem versus pallidiora, levia,

in substrato naturali: 39–125 μm longa, 4.5–7 μm crassa. Conidia acropleurogena, laevia, curvata, in agar TWA+W plerumque geniculata, 3-septata, septis fuscatis, cellula tertia ventricosae, atro rufo-brunnea, cellulis ceteris dilutionibus, in agar TWA+W: 29–46 $\times$ 15–19 μm , av. 37.6 $\times$ 16.8 μm ; *in substrato naturali*: 32–46 $\times$ 13–19 μm , av. 38.2 $\times$ 16.5 μm . Hilo protrudente.

Habitat: on living leaves of an undetermined plant in *Poaceae*, Hangzhou, Zhejiang Province, China, coll. Hui Deng, 9 Aug. 2000, HSAUP II₀4504 (=DH II₀0504), holotype.

Colonies in tap water agar+wheat straw (TWA+W) grey to brown, effuse, sporulating freely. Stromata not formed. Mycelium immersed in the substratum, subhyaline to pale brown, septate, branched, smooth, 1.0–4.5 μm thick. Conidiophores arising singly or in fascicles, terminally or laterally from hyphae, smooth, simple, straight or flexuous, septate, middle brown, paler towards the apex, in natural substratum, 39–125 μm long, 4.5–7 μm thick. Conidia acropleurogenous, 3-septate, in TWA+W the third cell from the base greatly inflated, mostly inequilateral to strongly curved, middle cells pale brown to mid-brown, the end cells paler: 29–46 $\times$ 15–19 μm , av. 37.6 $\times$ 16.8 μm ; in natural substratum the second and third septa from the base often darker and thicker, curved, apex rounded, basal cell obconic, middle cells medium to dark reddish brown, the end cells paler: 32–46 $\times$ 13–19 μm , av. 38.2 $\times$ 16.5 μm . Hilum protruding and consisting of a small appendiculate cell. First septum laid down in the conidia is median, second septum is distal or in the base.

The conidial sizes of the new species are similar in natural substratum and in culture, but the conidial color becomes paler in culture. The most similar species in conidial morphology is *Curvularia trifolii* (Kauffmann) Boedijn, but its conidia are smaller (20–38 $\times$ 8–16 μm ; Ellis 1966). The new species also resembles *Curvularia heteropogonis* Alcorn in the size of conidia, but the conidia of that species are clavate to obovoid and not so strongly curved (Alcorn 1990). Furthermore, the second and third septa from the base of the conidia of the new taxon are often darker and thicker, which is a striking character helping to distinguish it from other species.

Acknowledgments

We are grateful to Dr. Guo-Zhu Zhao and Miss Hui Deng for collecting some specimens and to Mr. Yue-Ming Wu for inking the drawings. The authors are grateful to Drs. B. Kendrick, Canada and Prof. Y.L. Guo, Institute of Microbiology, Academia Sinica for reviewing the manuscript.

Literature cited

- Alcorn JL. 1990. Additions to *Bipolaris*, *Cochliobolus* and *Curvularia*. *Mycotaxon* **39**: 361–392.
 Ellis MB. 1966. Dematiaceous hyphomycetes. VII: *Curvularia brachyspora*. *Mycol. Pap.* **106**: 1–57.
 Kilpatrick RA, Luttrell ES. 1967. An undescribed species of *Curvularia* pathogenic to *Dichanthium annulatum*. *Mycologia* **59**: 888–892.

Agarics on elephant dung in Kerala State, India

P. MANIMOHAN, K. AGRETIOUS THOMAS & V. S. NISHA

*pmanimohan@gmail.com*Department of Botany, University of Calicut
Kerala, 673 635, India

Abstract—Nineteen species representing twelve genera and five agaric families were found associated with elephant dung and are documented here along with a key to the species. The agarics are: *Agrocybe guruvayoorensis*, *Bolbitius coprophilus*, *Conocybe brunneoaurantiaca*, *C. pseudopubescens*, *C. volvata*, *Copelandia cyanescens*, *Entoloma anamikum*, *Macrocybe gigantea*, cf. *Panaeolina rhombisperma*, *Panaeolus antillarum*, *P. rickenii*, *Pholiotina indica*, *Psilocybe coprophila*, *Ps. pegleriana*, *Ps. subaeruginascens*, *Ps. subcubensis*, *Stropharia bicolor*, *S. rugosoannulata*, and *Volvariella volvacea*. Of the species encountered during the study, *Agrocybe guruvayoorensis*, *Conocybe volvata*, *Conocybe pseudopubescens*, *Pholiotina indica*, *Stropharia bicolor* are known to grow only on elephant dung.

Key words—coprophilous fungi, Basidiomycota, Agaricales

Introduction

Compared to other groups of fungi, basidiomycetes, with the exception of the “Coprini” and a few related genera, are rather rarely seen on dung. This is because dung, being an ephemeral substratum in most cases, cannot support long-life-cycled and large-fruit-bodied basidiomycetes. Elephant dung is an exception here because the droppings are comparatively more massive and composed mostly of ligno-cellulosic materials, and it takes almost a year before they are fully disintegrated. These features favor the colonization and development of agarics on elephant dung.

In the literature, however, only a few agarics have been reported to grow on elephant dung, e.g., *Conocybe corneri* Watling (Watling 1979), *Agrocybe stercoraria* Pegler, *Bolbitius vitellinus* (Pers.) Fr., *Coprinus sterquilinus* (Fr.) Fr., *Panaeolus antillarum*, *Psilocybe pseudobullacea* (Petch) Pegler, *Stropharia bicolor* (Pegler 1977) and *Psilocybe rostrata* (Petch) Pegler (Pegler 1986). However, during our studies on agarics of Kerala, we found several agarics growing on elephant dung. This prompted us to give an exclusive account of the

agarics (except the “Coprini”) associated with elephant dung in this region. As far as we know, this is the first comprehensive account in the world on agarics associated with elephant dung.

Materials & methods

Agarics were collected from dung of both wild and domesticated elephants. Conventional mycological techniques for examination of agaric specimens were used in the study. Acronyms of herbaria are according to Holmgren et al. (1990). Collections cited that are not followed by herbarium acronyms are in first author’s personal herbarium.

Results

Nineteen species belonging to twelve genera representing five agaric families were found associated with elephant dung. The families, genera, and species encountered are listed in Table 1.

Table 1: List of agaric families, genera, and species seen on elephant dung in Kerala, India

Families	Genera	Species
<i>Bolbitiaceae</i>	<i>Agrocybe</i>	<i>A. guruvayoorensis</i> *#
	<i>Bolbitius</i>	<i>B. coprophilus</i>
	<i>Conocybe</i>	<i>C. brunneoaurantiaca</i> *
		<i>C. pseudopubescentis</i> *#
		<i>C. volvata</i> *#
	<i>Copelandia</i>	<i>C. cyanescens</i>
	cf. <i>Panaeolina</i>	cf. <i>P. rhombisperma</i>
	<i>Panaeolus</i>	<i>P. antillarum</i>
		<i>P. rickenii</i>
	<i>Pholiotina</i>	<i>P. indica</i> *#
<i>Entolomataceae</i>	<i>Entoloma</i>	<i>E. anamikum</i> *
<i>Pluteaceae</i>	<i>Volvariella</i>	<i>V. volvacea</i>
<i>Strophariaceae</i>	<i>Psilocybe</i>	<i>P. coprophila</i>
		<i>P. pegleriana</i>
		<i>P. subaeruginascens</i>
		<i>P. subcubensis</i>
		<i>S. bicolor</i> #
	<i>Stropharia</i>	<i>S. rugosoannulata</i>
<i>Tricholomataceae</i>	<i>Macrocybe</i>	<i>M. gigantea</i>

* species known only from Kerala; # species known to grow only on elephant dung

Key to the agarics on elephant dung in Kerala

1. Spore-print cream-coloured or pink to dull pink 2
1. Spore-print black or some shade of brown 4
2. Spore-print cream-coloured; basidiomata very large and initially entirely whitish; spores $6-7.5 \times 4-5 \mu\text{m}$ *Macrocybe gigantea*
2. Spore-print pink to dull pink; basidiomata not very large and not entirely whitish; spores larger 3
3. Spores angular, with $5-7$ flat or concave facets, $9-13 \times 7-9.5 \mu\text{m}$; lamellar trama subregular to almost regular; volva absent *Entoloma anamikum*
3. Spores not angular, $8-9 \times 6-6.5 \mu\text{m}$, ellipsoid to subglobose; lamellar trama inversely bilateral; volva present *Volvariella volvacea*
4. Pileipellis neither a hymeniform layer nor an epithelium 5
4. Pileipellis is a hymeniform layer or rarely an epithelium 10
5. Chrysocystidia present; pileus mostly not hygrophanous 6
5. Chrysocystidia absent; pileus mostly hygrophanous. 7
6. Pileus strongly glutinous; annulus fugacious; spores ovo-ellipsoid, limoniform or subhexagonal in face-view, $10.5-14.5 \times 7.5-10 \times 6.5-8.5 \mu\text{m}$ *Stropharia bicolor*
6. Pileus subviscid; annulus thick, fleshy, strongly striate; spores ovo-ellipsoid in face view, $10-14.5 \times 7-9.5 \times 6.5-8.5 \mu\text{m}$.. *Stropharia rugosoannulata*
7. Basidiomata staining blue. 8
7. Basidiomata not staining blue. 9
8. Spores subrhomboid or limoniform in face view, $8-11 \times 6-8.5 \times 5-7 \mu\text{m}$ *Psilocybe subaeruginascens*
8. Spores subhexagonal in face view, $11-15 \times 7.5-10 \times 7-8.5 \mu\text{m}$.. *Psilocybe subcubensis*
9. Annulus present; pleurocystidia absent; spores $8-12 \times 6.5-8.5 \times 5.5-7 \mu\text{m}$ *Psilocybe pegleriana*
9. Annulus absent; pleurocystidia present, scattered; spores $10.5-15.5 \times 7.5-9.5 \times 7-9 \mu\text{m}$ *Psilocybe coprophila*
10. Spores mostly black, rarely purplish brown or dark fuscous brown 11
10. Spores never black but argillaceous brown, ochraceous brown or rust brown 14
11. Spores rhomboid to nodulose-subangular, dark-brown, partially discolored by concentrated H_2SO_4 , $10-12.5 \times 8-11.5 \mu\text{m}$ cf. *Panaeolina rhombisperma*
11. Spores not rhomboid to nodulose-subangular, blackish, not discolored by concentrated H_2SO_4 12
12. Metuloids present on the lamellae, spores $11-16.5 \times 9-11.5 \times 6.5-8.5 \mu\text{m}$ *Copelandia cyanescens*
12. Metuloids absent on the lamellae. 13

13. Basidiomata medium-sized to somewhat large; pileus white to cream-white; spores $12-16 \times 9-11 \times 7.5-9 \mu\text{m}$; chrysocystidia present. . *Panaeolus antillarum*
13. Basidiomata small to medium-sized; pileus brownish with a distinct whitish margin; spores $8-12 \times 6.5-9 \times 4.5-7.5 \mu\text{m}$; chrysocystidia absent *Panaeolus rickenii*
14. Pileus viscid and soon putrescent; pileus light orange to pastel red at the centre, fading centrifugally; hygrophanous and becoming greyish orange all over, sulcate-striate to the centre; lamellae free or nearly so; spores $9.5-13.5 \times 6.5-9 \times 6-8 \mu\text{m}$ *Bolbitius coprophilus*
14. Pileus not viscid and putrescent; lamellae not free 15
15. Stipe with an annulus 16
15. Stipe without an annulus 17
16. Basidiomata medium-sized to large, often fleshy; pileus light yellow to yellowish white; annulus median, evanescent; spores $9-13.5 \times 6.5-9 \times 6-8 \mu\text{m}$ *Agrocybe guruvayoorensis*
16. Basidiomata small to medium-sized, usually fragile; pileus reddish brown to pale orange; annulus central to superior, persistent, movable; spores $7-9 \times 4.5-6 \times 4-5.5 \mu\text{m}$ *Pholiotina indica*
17. Basidiomata volvate, medium-sized with pileus diameter more than 15 mm; spores $9.5-14.5 \times 7-9 \times 6-8 \mu\text{m}$ *Conocybe volvata*
17. Basidiomata not volvate, small with pileus diameter less than 15 mm 18
18. Spores $7-11 \times 6.5-8 \times 5-6.5 \mu\text{m}$; lamella-edge heteromorphous *Conocybe brunneoaurantiaca*
18. Spores $11.5-17.5 \times 7.5-12 \times 7-10 \mu\text{m}$; lamella-edge sterile *Conocybe pseudopubescens*

Documentation of Species

1. *Agrocybe guruvayoorensis* K.A. Thomas & Manim., Mycotaxon 86: 330 (2003).

SEL. DESCR. & FIGS. Thomas & Manimohan, Mycotaxon 86: 330-332 (2003).

Pale yellow pileus, an evanescent but distinct median annulus, spores that are $9-13.5 \mu\text{m}$ long and with a truncate germ-pore, sphaeropedunculate to vesiculose cheilocystidia, infrequent pleurocystidia that are similar to cheilocystidia, and caulocystidia restricted to the upper part of stipe are the characteristic features of this species.

Specimens examined: India, Kerala State, Thrissur District, Guruvayur: 14 July 1999, K. A. Thomas T316; 16 July 1999, K. A. Thomas T316b; 21 July 1999, K. A. Thomas T316c; 18 October 1999, K. A. Thomas T316d (all at herb. L).

2. *Bolbitius coprophilus* (Peck) Hongo, Mem. Fac. Lib. Arts. Educ., Shiga Univ. Nat. Sci. 9: 82 (1959).

SEL. DESCR. & FIGS. Thomas et al., Öst. Z. Pilzk 10: 88-90 (2001).

Bolbitius coprophilus is characterized by medium-sized, pinkish basidiomata; distinctly sulcate-striate, rather viscid pileal surface; adnexed or almost free lamellae; and

lageniform to utriform cheilocystidia. The hymeniform elements of the pileipellis are dispersed in a gelatinous matrix.

Specimens examined: India, Kerala State, Thrissur District, Guruvayur: 11 June 1999, A. Thomas T312; 17 June 1999, A. Thomas T312b; Kasaragod District, Adhoor: 16 September 2000, A. Thomas T312c (all at herb. WU).

3. *Conocybe brunneoaurantiaca* K.A. Thomas, Hauskn. & Manim., Öst. Z. Pilzk. 10: 90 (2001).

SEL. DESCR. & FIGS. Thomas et al., Öst. Z. Pilzk 10: 89–92 (2001).

Conocybe brunneoaurantiaca is characterized by small, brownish orange basidiomata; small lemon-shaped spores; lecythiform cheilocystidia with small capitula and long necks; and clavate or cylindric-flexuose caulocystidia in fascicles.

Specimens examined: India, Kerala State, Malappuram District, Nilambur: 24 August 2002, Nisha NVS122.

4. *Conocybe pseudopubescens* K.A. Thomas, Hauskn. & Manim., Öst. Z. Pilzk 10: 92 (2001).

SEL. DESCR. & FIGS. Thomas et al., Öst. Z. Pilzk 10: 92–94 (2001).

Small, thin-fleshed basidiomata; total absence of velar remnants; brownish, hygrophanous and pellucid striate pileus; large lentiform spores with very thick wall; and versiform caulocystidia that are never lecythiform are the characteristic features of this species.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 25 June 1997, A. Thomas T84; 25 May 1999, A. Thomas T84b (all at herb. WU).

5. *Conocybe volvata* K.A. Thomas, Hauskn. & Manim., Öst. Z. Pilzk. 10: 101 (2001).

SEL. DESCR. & FIGS. Thomas et al., Öst. Z. Pilzk 10: 101–103 (2001).

Conocybe volvata is characterized by small to medium-sized basidiomata; brown, hygrophanous, finely pellucid-striate pileus often with an obtuse umbo; very long stipe with a bifid, non-fragile, membranous volva; lentiform spores; distinct pavement cells in the hymenium, and versiform caulocystidia.

Specimens examined: India, Kerala State, Thrissur District, Guruvayur: 11 June 1999, A. Thomas T302b; 17 June 1999, A. Thomas T302c; 14 July 1999, A. Thomas T302d; 21 August 2000, A. Thomas T302e (all at herb. WU).

6. *Copelandia cyanescens* (Berk. & Broome) Singer, Lilloa 22: 473 (1951).

SEL. DESCR. & FIGS. Pegler, Kew Bull., Addit. Ser. 12: 377–379 (1977).

Small to medium-sized basidiomata discolored blue when bruised; parabolic to campanulate, whitish pileus; large, lenticular, limoniform spores; versiform cheilocystidia; and metuloidalean pleurocystidia are diagnostic of this species.

Specimens examined: India, Kerala State, Malappuram District, Angadipuram: 12 August 2002, Nisha NVS107; Thrissur District, Guruvayur: 9 September 2002, Nisha NVS128.

7. *Entoloma anamikum* Manim., A.V. Joseph & Leelav., Mycol. Res. 99 (9): 1091 (1995).

SEL. DESCR. & FIGS. : Manimohan et al., Mycol. Res. 99 (9): 1091 (1995).

Entoloma anamikum has small to medium-sized, whitish to pale brown basidiomata; infundibuliform pileus; deeply decurrent lamellae; heterodiametric-ovate spores with 5-7 flat or depressed sides; and occasional cheilocystidia.

Specimens examined: India, Kerala, Thrissur District, Guruvayur: 28 October 2002, Nisha NVS136; 2 July 2003, Nisha NVS136c. Malappuram District, Nilambur: 28 June 2003, Nisha NVS136b.

8. *Macrocybe gigantea* (Masse) Pegler & Lodge, Mycologia 90 (3): 497 (1998).

SEL. DESCR. : Pegler et al., Mycologia 90 (3): 497-498 (1998).

Macrocybe gigantea can be identified by very large, fleshy, heavy, whitish basidiomata; smooth, glabrous, estriate pileus; straw-yellow lamellae lacking both cheilocystidia and pleurocystidia; and ovo-ellipsoid to subglobose spores.

Specimens examined: India, Kerala, Thrissur District, Guruvayur: 27 May 1999, P. Manimohan, M750a; 17 June 1999, P. Manimohan, M750a. (Unfortunately these collections were lost subsequently.).

9. cf. *Panaeolina rhombisperma* Hongo, Mem. Shiga Univ. 23: 38 (1973).

SEL. DESCR. & FIGS. Hongo, Mem. Shiga Univ. 23: 38-39 (1973).

This fungus is similar to *Panaeolina rhombisperma* from Japan in almost all characters and particularly so in its rhomboid to subangular-tetrahedric spores. However, there is some difficulty in placing the present fungus in the genus *Panaeolina* because the colour of the spores of our collections fades in H_2SO_4 , a feature that is used to separate *Panaeolina* from rough-spored species of *Coprinus* and *Psathyrella*.

Specimens examined: India, Kerala state, Wayanad district, Ponkuzhy: 17 October 1999, K.A. Thomas, T338a; 18 October 1999, K.A. Thomas T338 b; 28 October 1999, K.A. Thomas T338c; 31 October 1999, K.A. Thomas T 338d (all at herb. L).

10. *Panaeolus antillarum* (Fr.) Dennis, Kew Bull. 15: 124 (1961).

SEL. DESCR. & FIGS. Pegler, Kew Bull., Addit. Ser. 6: 412-415 (1977).

Panaeolus antillarum is characterized by medium-sized basidiomata, whitish pileus that is slightly sticky when moist, solid stipe devoid of an annulus, presence of chrysocystidia, and spores that are somewhat hexagonal in outline with a truncate germ-pore.

Specimens examined: India, Kerala State, Malappuram District, Ramapuram: 16 August 2002, Nisha NVS109; 18 August 2002, Nisha NVS109b; Thrissur District, Guruvayur: 28 October 2002, Nisha NVS109c; 9 March 2003, Nisha NVS109d; 11 April 2003, Nisha NVS109e.

11. *Panaeolus rickenii* Hora, Trans. Brit. Mycol. Soc. 43: 454 (1960).

SEL. DESCR. & FIGS. Pegler, Kew Bull., Addit. Ser. 6: 410-413 (1977).

Panaeolus rickenii is a slender agaric with long stipe lacking annulus, dark brown hygrophanous pileus, lenticular spores with limoniform outline in face view, crowded versiform cheilocystidia, and numerous pileocystidia.

Specimens examined: India, Kerala State; Thrissur District, Guruvayur: 9 September 2002, Nisha NVS129; Malappuram District, Ramapuram: 22 October 2002, Nisha NVS133; 11 November 2002, Nisha NVS133b.

12. *Pholiotina indica* K.A. Thomas, Hauskn. & Manim. Öst. Z. Pilzk. 10: 109 (2001).
SEL. DESCR. & FIGS. Thomas et al., Öst. Z. Pilzk 10: 109–112 (2001).

Pholiotina indica has reddish brown to pale orange pileus, a distinct movable annulus, spores that are less than 10 µm long and with a distinct germ-pore, and versiform cheilocystidia and caulocystidia that are never capitate.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 1 October 1997, A. Thomas T179; 30 June 1998, A. Thomas T179b; 9 June 1999, A. Thomas T179f; 4 July 1997, A. Thomas T96; 18 August 1997, A. Thomas T96c; Ponkuzhy: 13 October 1998, A. Thomas T179c; 27 October 1998, A. Thomas T179d; 19 November 1998, A. Thomas T179e; Idukki District, Munnar: 11 October 1999, A. Thomas T179h; 12 October 1999, A. Thomas T179i (all at herb. WU).

13. *Psilocybe coprophila* (Bull.) P. Kumm., Fuhr. Pilzk.: 71 (1871).

SEL. DESCR. & FIGS. Guzmán, *Psilocybe*: 224–228 & Figs. 383–387 (1983); Thomas et al., Mycotaxon 83: 201–202 (2002).

Psilocybe coprophila has small basidiomata; subviscid, reddish brown, hygrophanous pileus; broadly adnate lamellae; non-annulate stipe; lentiform spores that are subhexagonal in face-view; versiform cheilocystidia; and rarely pleurocystidia similar to cheilocystidia.

Specimens examined: India, Kerala State, Idukki District, Munnar: 28 August 1997, A. Thomas T149 (at herb. XAL with part at herb. L).

14. *Psilocybe pegleriana* Guzmán, Doc. Mycol. 29 (116): 43 (2000).

SEL. DESCR. & FIGS. Guzmán, Doc. Mycol. 29 (116): 43 (2000); Thomas et al., Mycotaxon 83: 203–204 (2002).

Psilocybe pegleriana has small basidiomata; smooth, subviscid, brownish pileus that is obtusely umbonate when young; adnate to subdecurrent lamellae; annulate stipe; lentiform spores that are limoniform to subhexagonal in face-view; and versiform cheilocystidia. It is macroscopically very similar to *Psilocybe pseudobullacea* but the latter has pleurocystidia, larger spores and subcellular hypodermium.

Specimens examined: India, Kerala State, Thrissur District, Guruvayur: 11 June 1999, A. Thomas T 311; 17 June 1999, A. Thomas T 311b; 14 July 1999, A. Thomas T 311c; 18 October 1999, A. Thomas T 311e; Palakkad, District, Nelliampathy: 30 August 1999, A. Thomas T 311d; Kasaragod District, Adhoor: 16 September 2000, A. Thomas T311e (all at herb. XAL with part of each collection at herb. L).

15. *Psilocybe subaeruginascens* Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 123(1): 78 (1914).

SEL. DESCR. & FIGS. Guzmán, *Psilocybe*: 216–219 & Figs. 215–223 (1983); Thomas et al., Mycotaxon 83: 204–205 (2002).

Psilocybe subaeruginascens has small, bluing basidiomata; conic to conico-convex, subviscid, olive brown, hygrophanous pileus; broadly adnate to adnexed lamellae; annulate stipe; lentiform spores that are limoniform to subrhomboid in face-view; crowded sublageniform cheilocystidia; and scattered pleurocystidia similar to cheilocystidia.

Specimens examined: India, Kerala State, Calicut District, Vellarimala: 19 September 1997, A. Thomas T170; 20 September 1997, A. Thomas T170b; 8 November 1999, A. Thomas T170c (all at herb. XAL with part of each collection at herb. L).

16. *Psilocybe subcubensis* Guzmán, Mycotaxon 7: 248 (1978).

Figure 1

SEL. DESCR. & FIGS. Guzmán, *Psilocybe*: 249–251 & Figs.427–429 (1983); Thomas et al., Mycotaxon 83: 205–206 (2002).

Psilocybe subcubensis has medium-sized, readily-bluing basidiomata; conic to convex, subviscid, reddish brown, hygrophanous pileus; adnate to adnato-adnexed lamellae; annulate stipe; lentiform spores that are subhexagonal in face-view; crowded ventricose cheilocystidia; and scattered pleurocystidia that are often mucronate.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 17 June 1997, A. Thomas T76; 25 June 1997, A. Thomas T76b; 4 July 1997, A. Thomas T76c; 19 August 1997, A. Thomas T76d; 1 October 1997, A. Thomas T76e; 26 October 1997, A. Thomas T76f; 25 May 1999, A. Thomas T76g; 21 July 1999, A. Thomas T76h (all at herb. XAL with part of each collection at herb. L); Malappuram District, Nilambur: 28 June 2003, Nisha NVS142.

17. *Stropharia bicolor* Pegler, Kew Bull., Addit. Ser. 6: 463 (1977).

SEL. DESCR. & FIGS. : Pegler, Kew Bull., Addit. Ser. 6: 463–465 (1977).

Constant association with elephant dung, very thick glutinous covering over both the pileus and stipe, tuberculate-punctate lamella-edge, fugacious annulus, lenticular spores that are ovo-ellipsoid to limoniform or subhexagonal in face-view, cylindrical basidia with a median constriction, and narrowly cylindrical cheilocystidia often with a subcapitate apex are characteristic features of this species.

Specimens examined: India, Kerala State, Idukki District, Munnar: 29 August 1997, A. Thomas T152; Palakkad District, Nelliampathy: 29 August 1999, A. Thomas T152b; 30 August 1999, A. Thomas T152c (all at herb. L).

18. *Stropharia rugosoannulata* Farl. ex Murrill, Mycologia 14: 139 (1922).

SEL. DESCR. & FIGS. Noordeloos, Flora Agaricina Neerlandica 4: 61 (1999).

Stropharia rugosoannulata has medium-sized to large basidiomata; subviscid, reddish brown pileus surface; and ovo-ellipsoid spores. A superior, thick, persistent annulus that is deeply sulcate above and with triangular segments at margin is a diagnostic feature of this species.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 17 June 1997, A. Thomas T75; 25 June 1997, A. Thomas T75b; 4 July 1997, A. Thomas T75c; 21 July 1999, A. Thomas T75e; 25 July 1999, A. Thomas T75f; Palakkad District, Nelliampathy: 15 August 1997, A. Thomas T75d (all at herb. L).

19. *Volvarella volvacea* (Bull.) Singer, Lilloa 22: 401 (1951).

SEL. DESCR. & FIGS. : Pegler, Kew Bull., Addit. Ser. 6: 260–263 (1977).

Volvarella volvacea is a medium-sized species with grayish brown, radially fibrillose pileus; brownish, saccate, 2-3 lobed volva; and ellipsoid spores that are less than 10 µm long.



Fig. 1: *Psilocybe subcubensis* growing on elephant dung.

Specimens examined: India, Kerala, Malappuram District, Ramapuram: 11 November 2002, Nisha NVS137; 13 November 2002, Nisha NVS137b; Thrissur District, Guruvayur: 11 April 2003, Nisha NVS137c; 2 July 2003, Nisha NVS137d.

Discussion

The genus with the highest number of species encountered on elephant dung in Kerala was *Psilocybe* (four spp.) closely followed by *Conocybe* (three spp.). In Kerala, the following species have so far been seen only on elephant dung: *Agrocybe guruvayoorensis*, *Bolbitius coprophilus*, *Conocybe volvata*, *C. pseudopubescens*, *Copelandia cyanescens*, *Panaeolus antillarum*, *Panaeolus rickenii*, *Pholiotina indica*, *Psilocybe coprophila*, *Ps. pegleriana*, *Ps. subaeruginascens*, *Stropharia bicolor*, and *Stropharia rugosoannulata*. The following five species are known to grow only on elephant dung: *Agrocybe guruvayoorensis*, *Conocybe volvata*, *C. pseudopubescens*, *Pholiotina indica*, *Stropharia bicolor*; except for *Stropharia bicolor*, the other four species are to this date known only from Kerala. *Stropharia bicolor* was described by Pegler (1977) from East Africa where also it was constantly associated with elephant dung. *Bolbitius coprophilus*, *Psilocybe subcubensis*, and *Ps. pegleriana* are coprophilous species known to grow on dung of other animals as well. Other species are known from various substrata including dung of various animals.

This is the first record of *Entoloma anamikum*, *Macrocybe gigantea*, and *Volvariella volvacea* growing on elephant dung. *Macrocybe gigantea* is remarkable in that it produced the largest basidiomata. This agaric was never observed in isolated droppings in the wild but only on large heaps of dung of tamed elephants in captivity. This is understandable from the huge size of the basidiomata of this agaric which only a large substratum can support. *Entoloma anamikum* was originally described as growing on decaying rice straw (Manimohan et al. 1995) and all our subsequent spottings of this species in Kerala were on ligno-cellulosic material. It seems to be an obligate lignicolous species. Macroscopically, the Kerala collections of *Stropharia rugosoannulata* are indistinguishable from those illustrated by Imazeki et al. (1988) from Japan. To this date, however, *S. rugosoannulata* was known mostly from temperate and occasionally from subtropical localities of the world growing on rotting straw, mulch, etc. Cortez & Coelho (2004) found it growing on soil and litter in subtropical Brazil. Remarkably, all the Kerala collections of *S. rugosoannulata* were found growing on elephant dung.

Acknowledgments

We thank Dr. Gregory M. Mueller (Field Museum of Natural History, Chicago) and Dr. Vagner G. Cortez (Universidade Federal do Rio Grande do Sul, Brazil) for their presubmission reviews of the manuscript. Thanks are also due to Dr. Lorelei Norvell for editorial suggestions and Dr. Shaun Pennycook for nomenclatural advice.

Literature cited

- Imazeki R, Otani Y, Hongo T. 1988. Fungi of Japan. Yama-Kei Publ.: Tokyo(Japan).
- Cortez VG, Coelho G. 2004. The *Stropharioideae* (*Strophariaceae*, *Agaricales*) from Santa Maria, Rio Grande do Sul, Brazil. *Mycotaxon* 89: 355–378.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum Part I: The Herbaria of the World. 8th edn. New York Botanical Garden: New York (U.S.A.).
- Manimohan P, Joseph AV, Leelavathy KM. 1995. The genus *Entoloma* (*Agaricales*) in Kerala state, India. *Mycological Research* 99 (9): 1088–1097.
- Pegler DN. 1977. A preliminary agaric flora of East Africa. *Kew Bulletin, Additional Series* 6: 1–615.
- Pegler DN. 1986. Agaric flora of Sri Lanka. *Kew Bulletin, Additional Series* 12, 1–519.
- Watling R. 1979. Observations on the *Bolbitiaceae* XVII. Volvate species of *Conocybe*. *Beihefte zur Sydowia* 8: 401–415.

***Pyrenomyces* of the Russian Far East 2. *Mollicamarops stellata* gen. et sp. nov.**

LARISSA N. VASILYEVA

vasilyeva@ibss.dvo.ru

Institute of Biology and Soil Science

Far East Branch of the Russian Academy of Sciences

Vladivostok 690022, Russia

Abstract—*Mollicamarops stellata* is described from decaying wood. It was collected in the Bastak Nature Reserve (Jewish Autonomous Region, Russia), and is known only from this locality. The description and illustration of this fungus are provided.

Key words—*Boliniaceae*, *Camarops*, eastern Russia, systematics

Introduction

Since publication of the monograph “*Pyrenomyces* and *Loculoascomycetes*” (Vasilyeva 1998) in the series “Lower plants, fungi, and bryophytes of the Russian Far East,” a number of taxa have been described from this region, including the new species *Daldinia singularis* Ju et al. (1999) and *Pyrenomyxa morganii* Stadler et al. (2005), and new monotypic genera (Vasilyeva 2000, 2001) for *Actidiographium orientale* Lar. N. Vassiljeva and *Rossmania ukurunduensis* Lar. N. Vassiljeva. This is the second publication in the series of additions and corrections to the *Pyrenomyces* and *Loculoascomycetes* of the Russian Far East (see Vasilyeva, 2001).

The Bastak Nature Reserve (Jewish Autonomous Region, Russia), which is in the Russian Far East, was visited for only few days in August 2004 but the few collections that were made then were highly interesting, among them *Hypocrea megalosulphurea* Yoshim. Doi and *Podostroma giganteum* S. Imai. Both of these members of the *Hypocreales* were previously known only from Japan, and are recorded here for the first time in Russia. One intriguing specimen also appeared to be a member of the *Hypocreales* because of its fleshy, brightly colored stroma but its paraphysate hamathecium, darkly pigmented ascospores and black perithecial walls indicated that it is a member of the *Boliniaceae*, a pyrenomycete family of uncertain position. This specimen represents an undescribed species in a new genus. The description of this fungus follows.

Taxonomy

Mollicamarops Lar. N. Vassiljeva, **gen. nov.**

MYCOBANK # MB510602

Stromata late effusa, tenuata, mollia et colorata; perithecia semiimmersa, ostioli stellati praedita. Asci cylindrici, longe pedicellati, octospori, apparatus apicalis indistinctus et in liquore iodato Melzeri haud caerulescentis; paraphyses abundans et filiformes. Ascospores uniseriatae, unicellulares, ellipsoideae, brunneae.

Species typica: Mollicamarops stellata sp. nov.

Etymology: from Latin, *mollis* = soft, referring to the consistence of stromata, and *Camarops*, referring to the most similar genus.

Stromata widely effused, thin and soft, colored; perithecia semi-immersed, with black stellate ostioles. **Asci** cylindrical, long-stalked, 8-spored, with indistinct apical apparatus which does not stain in Melzer's iodine reagent. **Paraphyses** abundant and filiform. **Ascospores** uniseriate, unicellular, ellipsoid, brown.

Mollicamarops stellata Lar. N. Vassiljeva, **sp. nov.**

FIGS. 1–3

MYCOBANK # MB510603

Stromata late effusa, tenuata, mollia, ochracea vel fulva; perithecia 250–300 µm diam., semiimmersa, parieti nigri et ostioli stellati praedita. Asci cylindrici, octospori, p. sp. 40–55 × 4.5–5 µm, stipitibus 48–65 µm longitudine, apparatus apicalis indistinctus et in liquore iodato Melzeri haud caerulescentis; paraphyses abundans et filiformes, 140–160 µm longis, medio ca. 2 µm latis, apice ad 4–6 µm incrassatis. Ascospores uniseriatae, unicellulares, ellipsoideae, pallide brunnea, 5–7 × 3.5–4 µm.

Holotype: Russia, Jewish Autonomous Region, Bastak Nature Reserve, on decaying wood of a deciduous tree, 18 August 2004, leg. Larissa N. Vasilyeva (VLA).

Stromata widely effused, thin and soft, ochreous or fulvous; perithecia 250–300 µm diam., semi-immersed, walls black, ostiolar region conspicuously stellate or furrowed. **Asci** cylindrical, 8-spored, the spore-bearing parts 40–55 × 4.5–5 µm, stipe 48–65 µm, apical apparatus indistinct, KOH-. **Paraphyses** abundant among mature asci, narrow, 140–160 µm long, ca. 2 µm thick in the middle, reaching 4–6 µm at the tip, sinuous. **Ascospores** ellipsoidal, 5–7 × 3.5–4 µm, light brown, unicellular.

Discussion

The dark, stellate perithecial apex that stands out against the brightly colored stroma allows easy recognition of this species. Similar stellate ostiolar regions are also found in the *Diatrypaceae*. I do not see a close relationship between *Mollicamarops* and the *Diatrypaceae* despite this remarkable morphological convergence.

Mollicamarops stellata is somewhat similar to *Camarops flava* Samuels & J. D. Rogers, stromata of which are described as being thin and yellow to tan;



FIGS. 1-3. *Mollicamarops stellata* (VLA, holotype, light microscopy). Fig. 1. Stroma. Fig. 2. Asci and paraphyses. Fig. 3. Ascus and ascospores (scale bars: 1 = 2 mm, 2 = 10 μ m, 3 = 5 μ m).

but the latter species differs in having punctuate, non-stellate ostioles and ornamented ascospores (Samuels & Rogers 1987). *Camarops flava* grows on the pore surface of a decaying polypore and is only known from New Zealand, while *Mollicamarops stellata* occurs on wood in a very distant geographical area. The phenotype of *C. flava* suggests that it could represent a second species of *Mollicamarops*. The reasons for dividing *Camarops* into several genera on the basis of stromatal type, which parallels the delineation of genera in the families *Diatrypaceae* and *Xylariaceae*, were discussed when the genus *Camaropella* Lar. N. Vassiljeva was established (Vasilyeva 1997).

Acknowledgements

The author is grateful to Dr. Aleksey V. Chernyshov for helping with illustrations. The photographs were taken in the Far Eastern Center of Electron Microscopy (Institute of Marine Biology, Vladivostok), using digital camera Leica DFC300FX and microscopes Leica MZ75 and Leica DM 4500B. The author also acknowledges Dr. Gary Samuels (USDA-ARS-SBML, Beltsville, USA) and Dr. Vadim Mel'nik (Komarov Botanical Institute, St. Petersburg, Russia) for helpful comments and suggestions during presubmission review.

Literature cited

- Ju Y-M, Vasilyeva L, Rogers JD. 1999. *Daldinia singularis* sp. nov. from eastern Russia and notes on some other taxa. *Mycotaxon* 71: 405–412.
- Samuels GJ, Rogers JD. 1987. *Camarops flava* sp. nov., *Apiocamarops alba* gen. et sp. nov., and notes on *Camarops scleroderma* and *C. ustulinoides*. *Mycotaxon* 28: 45–59.
- Stadler M, Laessøe T, Vasilyeva L. 2005. The genus *Pyrenomyxa* and its affinities to other cleistocarpous *Hypoxyloideae* as inferred from morphological and chemical traits. *Mycologia* 97: 1129–1139.
- Vasilyeva LN. 1997. *Camarops pugillus* (Schw. : Fr.) Shear from the Russian Far East. *Mikol Fitopatol* 31: 5–7.
- Vasilyeva LN. 1998. *Pyrenomycetes* and *Loculoascomycetes*. In: Azbukina, Z. M. (ed.) Lower plants, fungi, and bryophytes of the Russian Far East. IV. Sankt-Petersburg: Nauka. 419 p. (in Russian).
- Vasilyeva LN. 2000. Hysteriaceous fungi in the Russian Far East. III. *Glonium* and *Actidiographium*. *Mikol Fitopatol* 34: 3–5.
- Vasilyeva LN. 2001. *Pyrenomycetes* of the Russian Far East - Additions and corrections. 1. *Rossmania ukurunduensis* gen. et sp. nov. *Mycoscience* 42: 399–401.

Macrofungi of Aydın Province, Turkey

HAKAN ALLI*, MUSTAFA İŞİLOĞLU* & M. HALİL SOLAK**

* *isiloglu@mu.edu.tr*

**Muğla University, Faculty of Science and Arts, Biology Department
48170, Muğla, Turkey*

***Muğla University, Ula Ali Koçman Vocational High School, Program of Fungi
48640 Ula, Muğla, Turkey*

Abstract — In this study, 2037 specimens of macrofungi were collected from different localities in Aydın province, west Anatolia, between the years 2002 and 2005, particularly during the autumn and spring seasons. As a result of the field and laboratory studies, 226 taxa belonging to 103 genera, and 48 families. Of the two classes represented, 25 taxa belong to *Ascomycetes* and 201 taxa to *Basidiomycetes*. The full checklist is available at http://www.mu.edu.tr/departments/biyoloji/_private/ozgecmisler/hakanalli/macrofungi_aydin.pdf

Key Words — Turkish fungi, macromycota, taxonomy

Introduction

In their paper on past macromycete research conducted in Turkey during 1932–2005, Sesli & Denchev (2005) state that about 1900 macrofungal taxa have thus far been reported from Turkey. However, present studies show that many of the mushroom taxa inhabiting different parts of Turkey have not yet been identified. Our study is the first to report on the macromycota of Aydın province.

Materials and methods

During field trips in the area (Figure 1), morphological and ecological characteristics of the macrofungi were recorded and collections were photographed in their natural habitats before being taken to the laboratory for identification. Specimens were identified by examining their macroscopic and microscopic features, using references by Breitenbach & Kränzlin (1984, 1986, 1991, 1995, 2000), Capelli (1984), Ellis & Ellis (1990), Marchand, (1971, 1973, 1975, 1977, 1980, 1982, 1983, 1986), Moser (1983), Orton & Watling (1979), Orton (1986), Phillips (1981), Watling (1982), and Watling & Gregory (1987, 1989). All collected specimens are now deposited in the fungarium of Muğla University.

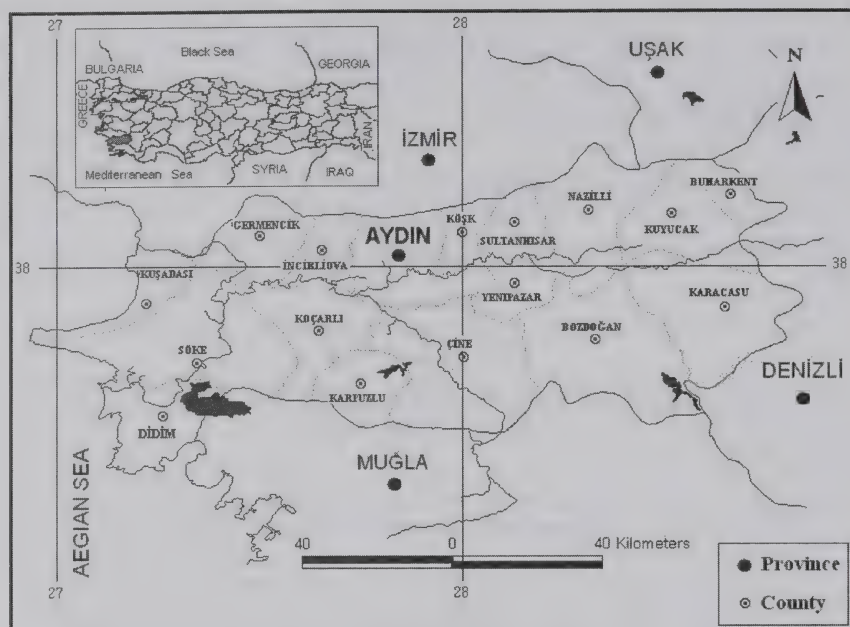


Figure 1. Map of Aydın province, west Anatolia, Turkey. Black indicates the study areas.

Results

In the present study, 226 taxa belonging to 48 families were recovered. Our complete report lists the taxa in alphabetical order. The distribution of the taxa in their families are: *Discinaceae* 2, *Helvellaceae* 7, *Morchellaceae* 9, *Pezizaceae* 4, *Pyronemataceae* 3, *Agaricaceae* 21, *Astraeaceae* 1, *Auriculariaceae* 2, *Bankeraceae* 1, *Bolbitiaceae* 13, *Boletaceae* 4, *Clavulinaceae* 2, *Cortinariaceae* 6, *Entolomataceae* 1, *Ganodermataceae* 5, *Geastraceae* 3, *Gloeophyllaceae* 3, *Gomphidiaceae* 1, *Gyroporaceae* 1, *Hapalopilaceae* 1, *Hydnangiaceae* 2, *Hygrophoraceae* 2, *Hygrophoropsidaceae* 1, *Hymenochaetaceae* 9, *Lycoperdaceae* 10, *Marasmiaceae* 13, *Meruliaceae* 1, *Nidulariaceae* 2, *Omphalotaceae* 1, *Paxillaceae* 1, *Phallaceae* 2, *Phanerochaetaceae* 2, *Pleurotaceae* 3, *Pluteaceae* 17, *Polyporaceae* 17, *Psathyrellaceae* 3, *Rhizopogonaceae* 2, *Russulaceae* 10, *Schizophyllaceae* 1, *Schizoporaceae* 1, *Sclerodermataceae* 3, *Sparassidaceae* 1, *Stereaceae* 6, *Strophariaceae* 10, *Suillaceae* 3, *Tremellaceae* 1, *Tricholomataceae* 10 and *Tulostomataceae* 2.

Discussion

In this study 226 taxa of macrofungi were collected from the study area, of which 25 belong to *Ascomycotina* and 201 to *Basidiomycotina*. There have been

some similar studies on the neighborhood regions; Işıloğlu & Watling (1992), Işıloğlu & Öder (1995), Solak et al. (1999), Solak & Yılmaz (2003), Afyon et al. (2005). This is the first detailed study for the region. There are some similarities between this study and mentioned former studies. The reason for these similarities is that four areas have similar habitats and flora. On the other hand, this study is a contribution to Turkish macromycota.

Acknowledgements

We would like to thank TÜBİTAK (The Scientific and Technical Research Council of Turkey) for supporting this project (TBAG-102T106) financially and special thanks due to Prof. Muhsin Konuk, Prof. Ahmet Afyon and Dr. Shaun Pennycook for reviewing the paper and for their helpful comments.

Literature cited

- Afyon A, Konuk M, Yağız D, Helfer S. 2005. A study of wood decaying macrofungi of the western Black Sea Region, Turkey, Checklist to Mycotaxon 93: 319-322.
- Breitenbach J, Kränzlin F. 1984-2000. Fungi of Switzerland. Vol: 1-5. Verlag Mycologia, Luzern.
- Capelli A. 1984. Fungi Europaei, Agaricus L.: Fr. Karsten, Libreria editrice Biella Giovanna, Italy.
- Ellis MB, Ellis JP. 1990. Fungi without gills (Hymenomycetes and Gasteromycetes), Chapman and Hill, London.
- Işıloğlu M, Öder N. 1995. Contributions to the macrofungi of mediterranean Turkey, Turkish Journal of Botany, 19: 603-609.
- Işıloğlu M, Watling R. 1992. Macromycetes of Mediterreanean Turkey, Edinburgh Journal of Botany 49 : 99-121.
- Moser M. 1983. Keys to agarics and boleti, Gustav Fischer Verlag, Stuttgart.
- Marchand A. 1971-1986. Champignons du nord et du midi. Tome I-IX: Les meilleurs comestibles. Societe Mycologique des Pyrénées Mediterranean, Perpignans.
- Orton P. 1986. British fungus flora. 4: *Pluteaceae: Pluteus & Volvariella*. Royal Botanic Garden, Edinburgh.
- Orton P, Watling R. 1979. British fungus flora 2: *Coprinaceae: Coprinus*. HMSO, Royal Botanic Garden, Edinburgh.
- Phillips R. 1981. Mushrooms and other fungi of Great Britain and Europe, Pan books Ltd., London.
- Sesli E, Denchev CM. 2005. Checklist of the myxomycetes and macromycetes in Turkey, Mycologia Balcanica 2: 119-160.
- Solak MH, Işıloğlu M, Gücin F, Gökler İ. 1999. Macrofungi of İzmir Province, Turkish Journal of Botany 23: 383-390.
- Solak MH, Yılmaz F. 2003. New Records from Mugla Province to the Turkish Macromycota, Ekoloji Journal 48: 10-12.
- Watling R. 1982. British fungus flora. 3: *Bolbitiaceae: Agrocybe, Bolbitius & Conocybe*. HMSO, Royal Botanic Garden, Edinburgh.
- Watling R, Gregory NM. 1987. British fungus flora, 5: *Strophariaceae & Coprinaceae* p.p. Royal Botanic Garden, Edinburgh.
- Watling R, Gregory NM. 1989. British fungus flora. 6: *Crepidotaceae, Pleurotaceae* and other pleurotoid agarics. Royal Botanic Garden, Edinburgh.

The discovery of *Amanita lilloi* in Brazil

FELIPE WARTCHOW

fwartchow@yahoo.com.br

Universidade Federal de Pernambuco, Departamento de Micologia/CCB
Av. Prof. Nelson Chaves, s/nº., CEP: 50670-901, Recife, PE, BRAZIL

RODHAM E. TULLOSS

ret@njcc.com

P. O. Box 57, Roosevelt, NJ, USA

MARIA A.Q. CAVALCANTI

xiliamac@terra.com.br

Universidade Federal de Pernambuco, Departamento de Micologia/CCB
Av. Prof. Nelson Chaves, s/nº., CEP: 50670-901, Recife, PE, BRAZIL

Abstract— *Amanita lilloi*, an interesting and rare species is reported for the first time from Brazil.

Key words—*Lepidella*, *Vittadiniae*, taxonomy

Introduction

Amanita Pers. is a well-established genus that is well supported by morphological, biochemical, and molecular data (Weiß et al. 1998, Drehme et al. 1999, Moncalvo et al. 2000). The main anatomical characterization of this pallid-spored genus is the presence of both bilateral lamella trama and longitudinally acrophysalidic stipe tissue (Bas 1969). Alternatively, schizohymenial development (Reijnders 1963, Bas 1969, Yang & Oberwinkler, 1999) of the basidioma characterizes the genus, in which all structural elements develop within a solid primordium and are separated by development of gelatinizing or friable intermediary tissues allowing edges of lamellae to separate from a partial veil or stipe surface, and hymenial surfaces of lamellae to be segregated from each other (Bas 1969).

The earliest record of this genus in Brazil was given by Rick (1906, 1937), who reported *A. pantherina* (DC. : Fr.) Krombh., *A. spissa* (Fr.) P. Kumm., *A. strobiliformis* (Paulet ex Vittad.) Bertill., *Armillaria bresadolae* Rick (= *Amanita bresadolae* (Rick) Rick nom. inval.) and *Amanitopsis plumbea* Rick, non

(Schaeff.) J. Schröt. from Rio Grande do Sul State. However Rick's publications and remaining material do not support interpretation at present, and these names are currently considered nomina dubia (Singer 1953, Bas 1978). Other authors recorded more species of *Amanita* from some Brazilian States: Homrich (1965) and Sobestiansky (2005) from Rio Grande do Sul; Grandi et al. (1984) and Pegler (1997) from São Paulo; Capelari & Maziero (1988) from Rondônia; Bas & de Meijer (1993), Stijve & de Meijer (1993) and de Meijer (2001) from Paraná and Giachini et al. (2000, 2004) from Santa Catarina.

This paper presents an unreported species of *Amanita* found in the Northeastern Brazilian State of Pernambuco.

Materials and Methods

We follow the methodology of Tulloss (1993). At the beginning of a set of spore data, the notation “[$a/b/c$],” where a , b , and c , are integers, is to be read “ a spores were measured from b basidiomata taken from c collections.” When ranges are provided in spore data in the form “(m -) n - o ($-p$),” where m , n , o , and p are integers, the values given are to be understood as follows: m is the smallest value observed or calculated and p is the largest value observed or calculated. In the range of values observed or calculated, the 5th percentile is n ; and the 95th percentile is o .

A summary of definitions of biometric variables follows:

w_{cs} = breadth of central stratum of lamella

w_{st} - near = distance from one side of central stratum to nearest base of basidium

w_{st} - far = distance from one side of central stratum to most distant base of basidium on the same side of the central stratum

L , (W) = the range of average lengths (widths) of spores of each basidioma examined

L' , (W') = the average of all lengths (widths) of spores measured

Q = the ratio of length to width of a spore or the range of such ratios for all spores measured

Q = the average of Q computed for all basidiomata examined

Q' = the average of all Q values computed for all spores measured.

Authorial citations follow Kirk & Ansell (1992). Herbarium codes used follow Holmgren et al. (1990) with the exception of “RET”, the private herbarium of Tulloss. Color naming and color codes follow Maerz & Paul (1930).

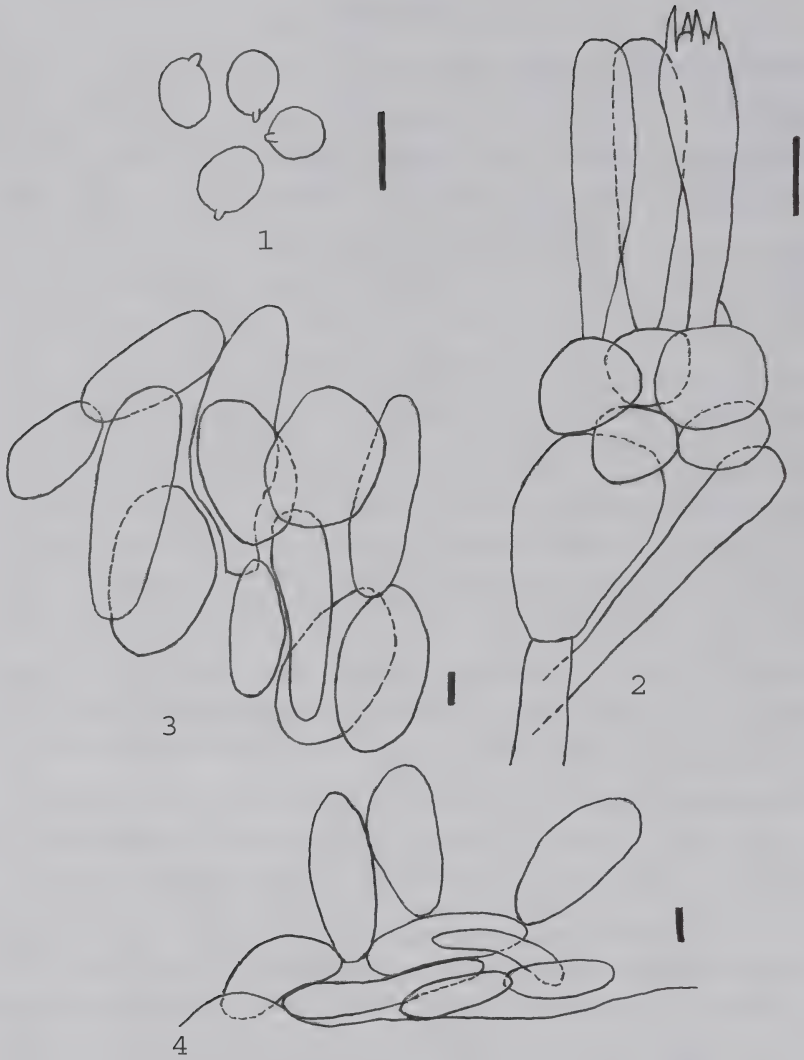
Exsiccata were deposited in the Herbarium of the Mycology Department of the Universidade Federal de Pernambuco (URM), with duplicate material deposited in “RET”, the private herbarium of R. E. Tulloss. Generic and infrageneric names and concepts follow Corner & Bas (1962) and Bas (1969).

Taxonomy

Amanita lilloi Singer, in Singer & Digilio, Lilloa 25: 245. 1952 ('1951'). FIGS. 1-5

Pileus: (14-) 20-40 mm wide, subglobose or hemispheric, then expanding to plano-convex and finally plano-concave in some old specimens, white or somewhat light beige ("Putty, Seed Pearl, Cambridge Buff" 11B2); *margin* entire, not striate, appendiculate; *universal veil* as numerous white then cream or yellow ochre (11L7) but rarely beige ("Putty, Seed Pearl, Cambridge Buff" 11B2) pyramidal warts up to 2 mm high in young specimens and having cottony aspect (under 10× lens), becoming scarce in mature specimens and concentrated mainly over disc; *context* fleshy, up to 5 mm thick at center, thinning toward margin, white, unchanging. **Lamellae:** narrowly adnexed in young basidiomata then free, moderately crowded, white then cream-colored and rarely pale yellowish cream (9B1) or more paler than "Polar Bear" (9B2) when fresh, ochraceous in exsiccata, up to 6 mm broad with concolorous edge; *lamellulae* attenuate to subtruncate, evenly distributed. **Stipe:** (16-) 23-50 × (2-) 4-6 mm, cylindrical, white with rather small and sometimes indistinct concolorous squamules; *bulb* radicating 10-20 × 2-9 mm, elongate-fusiform (mainly in young basidiomata) then elongate-radicating, sinuous in some specimens; *context* fleshy, white, unchanging, solid; *partial veil* superior to subsuperior, white, membranous, moderately thick, with verrucose white squamules on margin of lower surface, occasionally deciduous; *universal veil* very scarce or as remnants scattered over surface. **Odor and taste,** unpleasant. **Macrochemical spot tests,** none performed.

Basidiospores: [100/5/2] (7-) 7.5-9.5 (-10.5) × (6-) 6.5-7.5 (-8) μm , ($L = 8-8.6 \mu\text{m}$, $L' = 8.3 \mu\text{m}$; $W = 6.8-7 \mu\text{m}$, $W' = 7 \mu\text{m}$; $Q = (1.11-) 1.14-1.36 (-1.43)$; $Q = 1.16-1.22$, $Q' = 1.2$), amyloid, colorless, hyaline, smooth, thin walled, subglobose to broadly ellipsoid occasionally ellipsoid, usually or at least somewhat adaxially flattened; apiculus lateral; contents guttulate; white in deposit. **Basidia:** 32-41 × 9-12 μm , 4-sterigmate, with sterigmata up to 5-7 μm long, clamps present at base, but scarce. **Subhymenium:** up to 23 μm thick, as 2-4 layers of more or less isodiametric cells (e.g., 13.5 × 12.3 μm); $w_{st-near} = (29-) 44-69 \mu\text{m}$ (with some basidia appearing to arise directly from uninflated hyphae of the subhymenial base); $w_{st-far} = 66-86 \mu\text{m}$. **Lamella trama:** bilateral, with divergence of elements from the central stratum rather abrupt; $w_{cs} = 38-57 \mu\text{m}$; filamentous undifferentiated hyphae up to 2.5-4 μm wide, usually branched; slightly inflated terminal cells up to 12 μm wide; vascular hyphae 5-6 μm wide, very scarce. **Pileus context:** filamentous undifferentiated hyphae 2.5-5 μm wide, commonly branched, interwoven, forming a loose matrix where other elements occur; acrophysalides 47-54 × 30-37 μm ; vascular hyphae 3-14 μm wide, unbranched, with irregular outline in some regions. **Stipe context:**



Figures 1–4. *Amanita lilloi* (from F. Wartchow 2/2005). 1. Basidiospores. 2. Basidium and subhymenium. 3. Elements of the wart (tip). 4. Elements of the wart (base). Scale bar is 10 μm .

longitudinally acrophysalidic; acrophysalides (e.g.) $141 \times 20 \mu\text{m}$; filamentous undifferentiated hyphae $2.7\text{--}6.7 \mu\text{m}$ wide, branched; vascular hyphae $2\text{--}13 \mu\text{m}$ wide, unbranched. **Pileipellis:** difficult to distinguish. **Universal veil:** *On pileus:* filamentous undifferentiated hyphae $3.5\text{--}7.5 \mu\text{m}$ wide, unbranched, scarce; with elongate-fusiform slender elements at base of warts ($42\text{--}108 \times 12.5\text{--}28$



Figure 5. *Amanita liloi*. Basidiomata of the collection F. Wartchow 01/2006.

μm) arising from the pileus context and periclinal orientation near context, becoming anticlinal upward; inflated cells becoming more common toward tips of warts, with cells $61\text{--}110 \times 23\text{--}42 \mu\text{m}$, subparallel ascendant, broadly fusoid and clavate, with infrequent ovoid and subglobose cells, hyaline, thin-walled; vascular hyphae not observed; clamps occasional. *On stipe*: scarce, with elements arising from context, similar to cells of universal veil on pileus surface, with inflated cells $40\text{--}148 \times 15\text{--}35 \mu\text{m}$. **Partial veil**: undifferentiated hyphae $2\text{--}6 \mu\text{m}$ wide, interwoven, plentiful; inflated cells $10\text{--}15 \mu\text{m}$ wide, infrequent; vascular hyphae $2.5\text{--}7.5 \mu\text{m}$ wide, unbranched, occasional; with elements of universal veil present on lower side, fusiform-elongate $42\text{--}111 \times 12\text{--}45 \mu\text{m}$ or ovoid (e.g., $23\text{--}42 \times 16\text{--}25 \mu\text{m}$), hyaline; clamps rare.

Habitat: On soil in lawn, with some basidiomata at least 1 m from the nearest tree base (*Ficus* sp. - *Moraceae*).

Material examined: BRAZIL. Pernambuco: Recife, Campus UFPE (Reitores Avenue), 05.iv.2005 F. Wartchow 2/2005 (URM 78685, RET); same locality, 28.iii.2006, F. Wartchow 1/2006 (URM 78713, RET).

Additional material examined: ARGENTINA. Buenos Aires: Av. Alvear al 2900, 1949 J. E. Wright B-762 (BAFC); Locality not given, 10.i.1951, R. Singer s.n. (BAFC 30606).

Remarks: *Amanita lilloi* is a typical species of *Amanita* [subgenus *Lepidella* (Roze) Veselý emend. Corner & Bas (1962), section *Lepidella*, subsection *Vittadiniae* Bas (1969), stirps *Vittadinii* (Bas 1969: 347–349)] due to its subglobose to broadly ellipsoid amyloid spores; a non-striate and appendiculate pileus margin; lack of membranous volval limb at the stipe base; the dominance of concatenated, hyaline, elongate-fusiform cells in the universal veil; the frequent presence of clamps at the bases of basidia; and the distribution of volval remnants over the elongated basal part of stipe. Within this stirps, only two unpigmented species belong to the group with spore length under 9.5 µm: *A. lilloi*, originally described from Argentina (Singer & Digilio 1952), and *A. boliviana* Bas nom. prov., known from Bolivia (Bas 1969).

The present collection agrees in several points with *A. lilloi* as characterized by Singer & Digilio (1952) and Bas (1969): (1) the large, white and densely placed floccose pyramidal volval remnants on the pileus; (2) the adnexed lamellae in young basidiomata; (3) and the occurrence in gardens or lawns [although sometimes near woody plants in lawns (according to the annotation of J. E. Wright B-762 in BAFC, and in the case of our collections)]. On the other hand, our material differs from the original description of *A. lilloi* in the present species' (1) the smaller basidiomata, (2) slightly larger basidiospores [an isotype of *A. lilloi* had basidiospores [25/1/1] (6.5–) 7–8.5 × (5.5–) 6–7 µm according to Bas (1969)] and (3) its less squamulose stipe. The amount of volva on the stipe can be easily altered by environmental factors and handling prior to storage in a herbarium. Therefore we further examined the question of spore size.

The examination of some authentic material of *A. lilloi* from Argentina produced spore measurements (from the few undamaged mature spores) having ranges of length, width, and Q that contain the ranges of those variables as reported by Bas (above) and are more similar to the spore data reported for the Brazilian material: [39/3/2] (6.5–) 6.7–9 (–10.5) × 5–7 (–8) µm, (*L* = 7.2–8 µm; *L'* = 7.8 µm; *W* = 5.9–6.2 µm; *W'* = 6 µm; *Q* = (1.08–) 1.14–1.49 (–1.5); *Q* = 1.22–1.35 µm; *Q'* = 1.29 µm). We believe that the remaining differences between Argentine and Brazilian material can be attributed to the poor quality of preservation in the BAFC material.

Recently *A. lilloi* was reported again from Argentina, but there appears to have been a misdetermination: the accompanying illustration shows exclusively sub globose elements in the volval remnants (Wright & Albertó 2002: 120–121), which cannot occur in subsection *Vittadiniae* by its definition.

The Brazilian collection of *A. lilloi* resembles *A. boliviana* in the size of its basidiospores [(7.5–) 8–9.5 × 6.5–7.5 (–8.5) µm in *A. boliviana*], but the latter species has smaller squamules on the pileus and an exannulate stipe (Bas 1969).

Moreover, the sole collection of *A. boliviana* comes from a forest habitat.

Species of *Amanita* usually have an ectomycorrhizal relationship with one or more of a large variety of tree species (Trappe 1962, Smith & Read 1997), but there is no record suggesting any mycorrhizal symbiont for *A. lilloi* (see Singer & Digilio 1952, Bas 1969), which appears to occur commonly without or with few woody plants in the vicinity.

Acknowledgements

The authors thank Dr. Zhu L. Yang and Dr. Clark L. Ovrebo for critical review of the manuscript, Dr. Leonor C. Maia for her help and support and CNPq for financial support to the first author. Dr. Adriana A. Yano-Melo and Mr. Bruno T. Goto are gratefully acknowledged for their photographs, M.Sc Vagner G. Cortez for supplying literature and Dr. Marcus Alves for tree identification. R.E. Tulloss extends his gratitude to Dr. Jorge E. Wright (*in memoriam*) and curatorial staff of BAFC for the loan of all *Amanita* material in their collection.

References

- Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph on its section *Lepidella*. *Persoonia* 5: 285-579.
- Bas C. 1978. Studies in *Amanita*. I. Some Amazonian species. *Persoonia* 10: 1-22.
- Bas C, de Meijer AAR. 1993. *Amanita grillipes*, a new species in *Amanita* subsection *Vittadiniae* from southern Brazil. *Persoonia* 15: 345-350.
- Capelari M, Maziero R. 1988. Fungos macroscópicos do estado de Rondônia, região dos Rios Jaru e Ji-Paraná. *Hoehnea* 15: 28-36.
- Corner EJH, Bas C. 1962. The genus *Amanita* in Singapore and Malaya. *Persoonia* 2: 241-304.
- Drehmel D, Moncalvo J-M, Vilgalys R. 1999. Molecular phylogeny of *Amanita* based on large-subunit ribosomal DNA sequences: implications for taxonomy and character evolution. *Mycologia* 91: 610-618.
- Giachini AJ, Oliveira VL, Castellano MA, Trappe JM. 2000. Ectomycorrhizal fungi in *Eucalyptus* and *Pinus* plantations in Southern Brazil. *Mycologia* 92: 1166-1177.
- Giachini AJ, Souza LAB, Oliveira, VL. 2004. Species richness and seasonal abundance of ectomycorrhizal fungi in plantation of *Eucalyptus dununii* and *Pinus taeda* in Southern Brazil. *Mycorrhiza* 14: 375-381.
- Grandi RAP, Guzmán G, Bononi VLR. 1984. Adições às *Agaricales* (*Basidiomycetes*) do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil. *Rickia* 11: 27-33.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I. The herbaria of the world, 8th ed. New York Botanical Garden, Bronx.
- Homrich MH. 1965. Nota sobre *Amanita muscaria* (L.: Fr.) Pers.: Hooker no planalto Riograndense. *Sellowia* 17: 77-78.
- Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of Fungi Supplement, Cambridge.
- Maerz AJ, Paul MR. 1950. A Dictionary of Color. 2nd ed., McGraw-Hill Book Company, Inc., New York.
- De Meijer AAR. 2001. Mycological work in the Brazilian state of Paraná. *Nova Hedwigia* 72: 105-159.
- Moncalvo J-M, Drehmel D, Vilgalys R. 2000. Variation in modes and rates of evolution in nuclear and mitochondrial ribosomal DNA in the mushroom genus *Amanita* (*Agaricales*, *Basidiomycota*): phylogenetic implications. *Mol. Phylogen. Evol.* 16: 48-63.

- Pegler DN. 1997. The Agarics of São Paulo, Brazil. Royal Botanical Gardens, Kew.
- Reijnders AFM. 1963. Les problèmes de développement des carpophores des *Agaricales* et de quelques groupe voisins. Junk, Den Haag.
- Rick J. 1906. Pilze aus Rio Grande do Sul. Brotéria Ser. Bot. 5: 5-53.
- Rick J. 1937. Agarici Riograndensis. Lilloa 1: 307-346.
- Singer R. 1953. Type studies on *Basidiomycetes* VI. Lilloa 26: 57-159.
- Singer R, Digilio APL. 1952 ('1951'). Pródromo de la Flora Agaricina Argentina. Lilloa 25: 5-461.
- Smith SE, Read DJ. 1997. Mycorrhizal symbiosis. Academic Press, San Diego.
- Sobestiansky G. 2005. Contribution to a macromycete survey of the states of Rio Grande do sul and Santa Catarina in Brazil. Braz. Arch. Biol. Technol. 48: 437-457.
- Stijve T, de Meijer AAR. 1993. Macromycetes from the State of Paraná, Brazil. 4. The psychoactive species. Arq. Biol. Tecnol. 36: 313-329.
- Trappe JM. 1962. Fungus associates of ectotrophic mycorrhizae. Bot. Rev. 28: 538-606.
- Tulloss RE. 1993. *Amanita pachysperma*, *Amanita subvirginiana* and *Amanita virginiana* (taxonomy and distribution) with notes in descriptions of the lamella trama in *Amanita*. Mycotaxon 49: 449-475.
- Weiß M, Yang Z-L, Oberwinkler F. 1998. Molecular phylogenetic studies in the genus *Amanita*. Can. J. Bot. 76: 1170-1179.
- Wright JE, Albertó E. 2002. Guía de hongos de la Región Pampeana. I. Hongos con laminillas. L.O.L.A., Buenos Aires.
- Yang ZL, Oberwinkler F. 1999. Die Fruchtkoperentwicklung von *Amanita muscaria* (*Basidiomycetes*). Nova Hedwigia 58: 441-468.

A new species of *Perenniporia* (Basidiomycota, Aphyllophorales) from eastern China

BAO-KAI CUI

baokaicui@yahoo.com.cn

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

*Graduate School, Chinese Academy of Sciences
Beijing 100039, China*

YU-CHENG DAI*

yuchengd@yahoo.com

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

CONY DECOCK

conydecock@hotmail.com

*Mycothèque of the Catholic University of Louvain (BCCMtm/MUCL)
Louvain-la-Neuve 1348, Belgium*

Abstract — A new poroid wood-inhabiting basidiomycete, *Perenniporia rhizomorpha*, collected in Anhui and Fujian Province, eastern China, is described and illustrated. The new species has an annual growth habit, resupinate basidiocarps with a cream buff to yellow buff pore surface, and a cream to buff coloured margin to which rhizomorphs are joined. Microscopically it is characterized by encrusted contextual skeletal hyphae. The basidiospores are ellipsoid, not truncate, dextrinoid and cyanophilous, $5.3\text{--}6.5 \times 4.1\text{--}5.2 \mu\text{m}$.

Key words — polypore, taxonomy, wood-rotting fungi

Introduction

Perenniporia Murrill is a large, cosmopolitan genus. According to the modern definition it is characterized by ellipsoid to distinctly truncate basidiospores, which usually are thick-walled, and have a cyanophilous and variably dextrinoid reactions; its hyphal structure is di- to trimitic with clamp connections on generative hyphae, and its vegetative hyphae are cyanophilous, and variably dextrinoid (Decock & Stalpers 2006). Until now 88 species have been described

in the genus, and most of them occur in the tropics or subtropics. Extensive studies of the genus have been recently undertaken by Dai et al. (2002), Decock (2001a, b), Decock & Ryvarden (1999a, b, 2000, 2003a, b), Decock et al. (2000, 2001), and Hattori & Lee (1999).

Knowledge of *Perenniporia* in China was summarized by Dai et al. (2002). Recently, two more species of *Perenniporia* new to China were reported by Cui et al. (2006), and altogether 24 species have been recorded from the country. During an investigation of wood-inhabiting fungi in eastern China, an additional undescribed species of *Perenniporia* was found, and it is described here.

Materials and methods

The studied specimens are deposited at the Herbarium of the Institute of Applied Ecology, the Chinese Academy of Sciences (IFP). Measurements and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. The microscopic routine used in the study fellow Dai & Niemelä (1997). Spores were measured from sections cut from the tubes. IKI = Melzer's reagent, KOH = 5% potassium hydroxide, and CB = Cotton Blue. CB+ = cyanophilous, CB- = acyanophilous, and IKI- = both inamyloid and indextrinoid reaction. In expressing variation in size of spores, 5% of measurements were excluded from each end of the size range, and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetic mean of all spores), W = mean spore width (arithmetic mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width), n = number of spores measured from a given number of specimens. The width of a basidium was measured at the thickest part, and the length was measured from the apex (sterigmata excluded) to the basal septum. Sections were studied at magnifications up to $\times 1000$ using a Nikon Eclipse E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms are from Petersen (1996) and Anonymous (1969).

Description

Perenniporia rhizomorpha B.K. Cui, Y.C. Dai & Decock, sp. nov.

Fig. 1

Mycobank # mb510573

Carpophorum annuum, *resupinatum*. *Facies* *pororum cremeo-bubalina vel luteola*, *pores* *rotundi vel angulati*, 4–6 per mm. *Systema hypharum dimiticum*, *hyphae generatoriae fibulatae*, *hyphae skeletales subiculi* 2.3–4.2 μm in diam. *Sporae hyalinae, ellipsoideae, dextrinoideae*, CB+, 5.3–6.5 $\times$ 4.1–5.2 μm .

Type. — China. Anhui Province, Huangshan County, Yellow Mountains National Park, on fallen angiosperm trunk, 13.X.2004 Dai 6165 (holotype in IFP, isotype in HMAS & H).

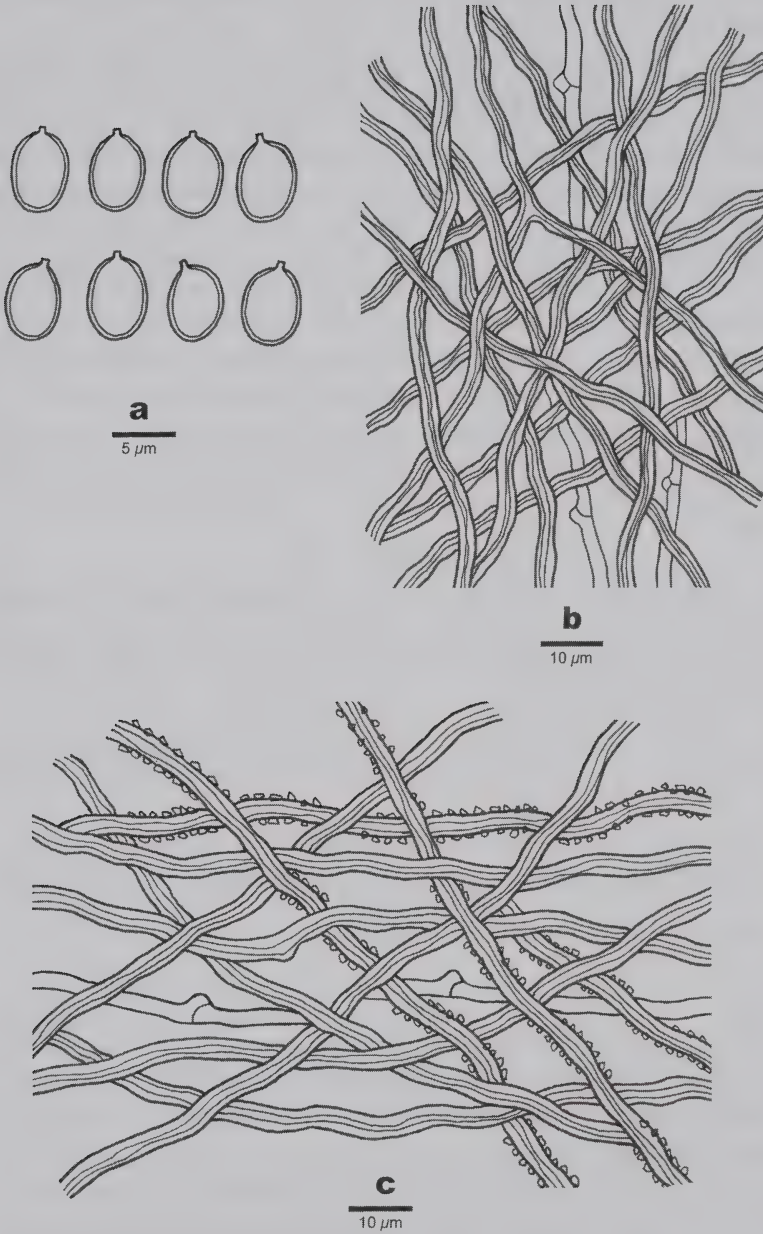


Fig. 1. Microscopic structures of *Perenniporia rhizomorpha* (drawn from the holotype).
—a: Basidiospores. —b: Hyphae from trama. —c: Hyphae from subiculum.

Etymology. — *rhizomorpha* (Lat.): referring to the rhizomorphic character of basidiocarps.

Fruitbody. — Basidiocarps annual, resupinate, adnate, corky, without odour or taste when fresh, becoming corky to leathery upon drying, up to 15 cm long, 4 cm wide, and 3 mm thick at centre. Sterile margin distinct, cream buff or yellow-buff to yellowish orange, up to 1 mm wide, usually with cream to buff coloured rhizomorphs. Pore surface cream buff to yellowish buff when fresh, becoming buff to buff-yellow upon drying; pores round to angular, 4–6 per mm; dissepiments thin, entire. Subiculum cream to buff, corky, azonate, up to 1 mm thick. Tubes concolorous with the pore surface, corky to leathery, up to 2 mm long.

Hyphal structure. — Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB+, tissue unchanged in KOH.

Subiculum. — Generative hyphae infrequent, hyaline, thin-walled, rarely branched, 1.5–3.3 µm in diam; skeletal hyphae dominant, hyaline, thick-walled with a distinct lumen, rarely branched, interwoven, usually encrusted with fine crystals, 2.3–4.2 µm in diam.

Tubes. — Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, 1.4–3 µm in diam; skeletal hyphae dominant, hyaline, thick-walled with a narrow lumen to subsolid, occasionally branched, strongly interwoven, 1.6–3 µm in diam. Cystidia and cystidioles absent; hymenia collapsed, basidia and basidioles not seen.

Spores. — Basidiospores ellipsoid, not truncate, hyaline, thick-walled, smooth, dextrinoid, CB+, (5–)5.3–6.5(–7) × (4–)4.1–5.2(–6) µm, L = 5.96 µm, W = 4.78 µm, Q = 1.22–1.28 (n = 90/3).

Additional specimens (paratypes) examined. — China. Anhui Province, Huangshan County, Yellow Mountains National Park, on fallen angiosperm trunk, 13.X.2004 Dai 6166 (IFP); Fujian Province, Wuyishan County, Wuyishan Nature Reserve, on fallen angiosperm branch, 19.X.2005 Dai 7248 (IFP).

Type of rot. — White rot.

Remarks — Macroscopically, *Perenniporia rhizomorpha* is characterized by an annual growth habit, resupinate basidiocarps with cream to buff coloured rhizomorphs, and a cream-buff to yellow-buff pore surface. Microscopically it is characterized by non-truncate and ellipsoid basidiospores, and by encrusted contextual skeletal hyphae.

Two other *Perenniporia* species produce rhizomorphs at their margins, viz. *P. japonica* (Yasuda) T. Hatt. & Ryvarden (Núñez & Ryvarden 2001) and *P. aurantiaca* (A. David & Rajchenb.) Decock & Ryvarden (Decock & Ryvarden 1999a).

Perenniporia japonica differs from *P. rhizomorpha* by having a whitish to isabelline pore surface, and ellipsoid to truncate and smaller basidiospores ($4\text{--}5.2 \times 3\text{--}3.9 \mu\text{m}$, Dai et al. 2002).

Perenniporia aurantiaca is distinguished from *P. rhizomorpha* by having a bright orange pore surface, smaller pores (7–8 per mm), and typically truncate and smaller basidiospores ($4.2\text{--}5.5 \times 3\text{--}4 \mu\text{m}$). Furthermore, the species is endemic to neotropical areas (Decock & Ryvarden 1999a), while *P. rhizomorpha* is from warm- temperate China.

Macroscopically, *Perenniporia rhizomorpha* looks similar to *P. subacida* (Peck) Donk, sharing resupinate, cream to yellowish basidiocarps, and similar pores (4–6 per mm). The unbranched, strongly dextrinoid skeletal hyphae together with non-truncate basidiospores also resemble those of *P. subacida* and both species in all probability belong to the same complex. *P. subacida*, however, lacks rhizomorphs, and its basidiospores are smaller ($4.3\text{--}5.4 \times 3.2\text{--}4.1 \mu\text{m}$, Dai et al. 2002). In addition, its tramal hyphae are parallel along the tubes, rather than strongly interwoven as in *P. rhizomorpha*.

Acknowledgements

We thank Prof. Nils Hallenberg (GB, Sweden) and Dr. Peter Buchanan (PDD, New Zealand) who reviewed the manuscript. The research is supported by the Ministry of Science and Technology of China (Project No. 2005DFA30280) and the Chinese Academy of Sciences (Project No. KSCX2-YW-Z-036). Cony Decock gratefully acknowledges the financial support received from the Federal Science Policy Office (contracts C3/10/003 and BL/10/C41) and from the FNRS (travel grant as part of the cooperation agreement with the NSFC, V 4/345 – CB/AP – 7.853).

Literature cited

- Anonymous. 1969: Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London.
- Cui BK, Dai YC, Decock C. 2006: Two species of *Perenniporia* (Basidiomycota, Aphyllophorales) new to China. *Fungal Science* 21: 17–21.
- Dai YC, Niemelä T. 1997: Changbai wood-rotting fungi 6. Study on *Antrodiella*, two new species and notices on some other species. *Mycotaxon* 64: 67–81.
- Dai YC, Niemelä T, Kinnunen J. 2002: The polypore genera *Abundisporus* and *Perenniporia* (Basidiomycota) in China, with notes on *Haploporus*. *Ann. Bot. Fennici* 39: 169–182.
- Decock C. 2001a: Studies in *Perenniporia*. Some Southeast Asian taxa revisited. *Mycologia* 93: 774–795.
- Decock C. 2001b: Studies in *Perenniporia* (Basidiomycetes, Polypores): African taxa 1. *Perenniporia dendrohyphidia* and *Perenniporia subdendrohyphidia*. *Syst. Geogr. Pl.* 71: 45–51.
- Decock C, Buchanan P, Ryvarden L. 2000: Revision of some Australasian taxa of *Perenniporia* (Basidiomycetes, Aphyllophorales). *Australian Syst. Bot.* 13: 823–844.
- Decock C, Figueroa H, Ryvarden L. 2001: Studies in *Perenniporia*. *Perenniporia contraria* and its presumed taxonomic synonym *Fomes subannosus*. *Mycologia* 93: 196–204.

- Decock C, Ryvarden L. 1999a: Studies in neotropical polypores. Some coloured resupinate *Perenniporia* species. Mycol. Res. 103: 1138–1144.
- Decock C, Ryvarden L. 1999b: Studies in *Perenniporia*: *Perenniporia detrita* and its taxonomic synonyms. Mycologia 91: 386–395.
- Decock C, Ryvarden L. 2000: Studies in neotropical polypores 6. New resupinate *Perenniporia* species with small pores and small basidiospores. Mycologia 92: 354–360.
- Decock C, Ryvarden L. 2003a: *Perenniporiella* gen. nov. segregated from *Perenniporia*, including a key to neotropical *Perenniporia* species with pileate basidiomes. Mycol. Res. 107: 93–103.
- Decock C, Ryvarden L. 2003b: Studies in *Perenniporia* (Basidiomycetes, *Perenniporiales*) *Pseudopiptoporus chocolates* comb. nov., a synonym of *Perenniporia ahmadii*, and a note on *Pseudopiptoporus*. Nova Hedwigia 77: 199–211.
- Decock C, Stalpers J. 2006: Studies in *Perenniporia*: *Polyporus unitus*, *Boletus medulla-panis*, and the nomenclature of *Perenniporia*, *Poria*, and *Physisporus*, with a note on the European *Perenniporia* taxa with a resupinate basidiome. Taxon 55 (in press).
- Hattori T, Lee S. 1999: Two new species of *Perenniporia* described from a lowland rainforest of Malaysia. Mycologia 91: 525–531.
- Núñez M, Ryvarden L. 2001: East Asian polypores 2. *Polyporaceae* s. lato. Synopsis Fungorum 14: 165–522.
- Petersen JH. 1996: Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.

A new species of *Haploporus* (Basidiomycotina) from China

JUAN LI

smilejuanzili@sina.com

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

*Graduate School, Chinese Academy of Sciences
Beijing 100039, China*

YU-CHENG DAI*

**Corresponding author, yuchengd@yahoo.com*

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

HAI-SHENG YUAN

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

Abstract — *Haploporus latissporus* from Central China is described and illustrated as new. It is characterized by small and thin basidiocarps, distinctly thick basidiospores, and by twigs of *Pinus* as substrate. All known species of *Haploporus* are surveyed, and a key for all species in the genus is provided. In addition, based on examination of specimens, spore dimensions of each species are supplied in the key.

Key words — *Aphyllophorales*, polypores, taxonomy

Introduction

Haploporus Bondartsev & Singer (*Polyporaceae*, *Aphyllophorales*) is characterized by a di-trimitic hyphal structure with cyanophilous skeletal hyphae, generative hyphae bearing clamp connections, and by thick-walled, ornamented, cyanophilous basidiospores. The genus is very closely related to *Pachykytospora* Kotl. & Pouzar (Kotlaba & Pouzar 1963), and the latter was merged with *Haploporus* by Dai et al. (2002).

During investigation of wood-inhabiting fungi in Henan Prov., central China, two poroid, resupinate specimens were collected on fallen twigs of *Pinus*. These two specimens have a dimitic to trimitic hyphal structure with generative hyphae

bearing clamp connections; skeletal hyphae are cyanophilous, basidiospores are thick-walled, ornamented with warts and cyanophilous. These features are characteristic of *Haploporus*. After checking all species in the genus (Dai & Li 2002, Dai et al. 2002, Hattori 2002, Natarajan & Kolandavelu 1993, Piątek 2005), we could not find an existing name, and the species is here described as new. In addition, after studying all known species of *Haploporus*, a key to species was prepared. Sixty spores or more were measured from each species, and statistical variation of the spore dimensions of each species is included in the key.

Materials and methods

Those specimens collected by the present authors are deposited at the Herbarium of the Institute of Applied Ecology, the Chinese Academy of Sciences (IFP). To support our research specimens from Europe and Africa were also studied. All specimens examined are listed below. Spores were measured and drawn from slide preparations stained with Cotton Blue and Melzer's reagent. Abbreviations: IKI = Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous reaction, CB- = acyanophilous, while IKI- = both inamyloid and indextrinoid. At least 60 spores were measured from each species, and statistical variations of spore dimensions of each species are included in the key; 5% of measurements were excluded from each end of the size range and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetic mean of all spores), W = mean spore width (arithmetic mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width), n = number of spores measured from a given number of specimens. The width of basidia and cystidioles was measured at the thickest part, and the length was measured from the apex (sterigmata excluded) to the basal septum. Sections were studied at magnifications up to $\times 1000$ using a Nikon Eclipse E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms are from Petersen (1996) and Anonymous (1969).

Description

Haploporus latisporus Juan Li & Y.C. Dai, sp. nov.

Fig.1

MYCOBANK # MB510574

Carpophorum annuum, *resupinatum*; *facies pororum albida vel cremea*; *pori rotundi vel angulati*, 2–3 per mm. *Systema hypharum dimiticum vel trimiticum*, *hyphae generatoriae fibulatae*, *hyphae skeletales subiculi* 1.5–2.4 μm in diam. *Sporae hyalinae vel pallide aureae, oblongo-ellipsoideae vel ellipsoideae, crassitunicatae*, 13–16.5 $\times$ 8–10 μm .

Type. — China. Henan Prov., Xinyang, Jigongshan, on fallen twig of *Pinus*, 23.VIII.2005 Li 131 (Holotype in IFP, isotype in H).

Etymology — *latisporus* (Lat.): referring to the wide spores.

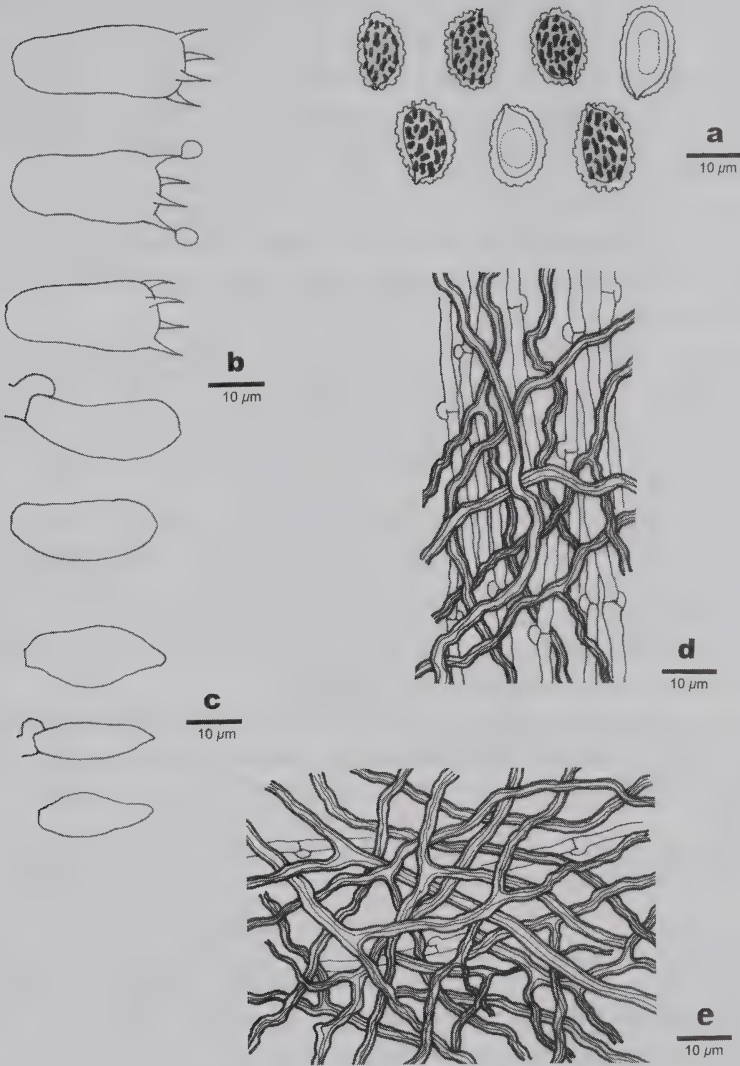


Fig. 1. Anatomical details of *Haploporus latiporus* (drawn from the holotype).
 — a: Basidiospores. — b: Basidia and basidioles. — c: Cystidioles.
 — d: Hyphae from trama. — e: Hyphae from subiculum.

Fruitbody — Basidiocarps annual, resupinate, mostly in small patches, difficult to separate from the substrate, soft corky when fresh, becoming corky upon drying, single patch up to 2 cm long, 1.5 cm wide and 1 mm thick at centre. Pore surface white to cream, becoming cream to buff-yellow upon drying, sterile margin almost lacking; pores round to angular, (1–)2–3 per mm; dissepiments thin, slightly lacerate. Subiculum white, corky, very thin, almost lacking. Tubes concolorous with pore surface, corky, about 1 mm long.

Hyphal structure — Hyphal system dimitic to trimitic; generative hyphae bearing clamp connections, hyaline, thin-walled; skeletal hyphae dominant, thick-walled, frequently branched, IKI– or very weakly dextrinoid, CB+, tissue unchanged in KOH.

Subiculum — Subicular hyphae tightly interwoven; generative hyphae hyaline, thin-walled, rarely branched, 1.8–3 µm in diam.; skeletal hyphae hyaline, thick-walled with a narrow lumen, flexuous, often branched, 1.5–2.4 µm in diam.; branched hyphae thick-walled with a narrow lumen to subsolid, flexuous, 0.7–2 µm in diam.

Tubes — Tramal hyphae interwoven; generative hyphae frequent, hyaline, thin-walled, rarely branched, 1.5–3.2 µm in diam.; skeletal hyphae thick-walled with a narrow lumen, occasionally branched, 1.8–3.8 µm in diam. Cystidioles present, fusiform, 24–32 × 7–9 µm. Basidia broadly clavate or barrel-shaped with 4-sterigmata and a basal clamp connection, 24–40 × 12–16 µm; basidioles similar in shape to basidia, but slightly smaller.

Spores — Basidiospores oblong-ellipsoid to ellipsoid, hyaline to pale yellowish, thick-walled, ornamented with warts (warts to almost 2 µm length), IKI–, CB+, 13–16.5(–17) × (7.5–)8–10 µm, L = 14.3 µm, W = 8.67 µm, Q = 1.64–1.66 (n = 80/2).

Additional specimen (paratype) examined — China, Henan Prov., Xinyang, Jigongshan, on fallen twig of *Pinus*, 23.VIII.2005 Li 120 (IFP).

The new species is distinguished from other species of *Haploporus* by big, distinctly broad spores (up to 10 µm in width). The pale yellowish spores are unique in the genus, and the ornamentation of the spores extends to 2 µm thick. All previously recorded species of *Haploporus* are found on angiosperm wood, but *H. latisporus* seems to be restricted to pine wood.

Haploporus latisporus has similar pore size to that of *Haploporus thindii* (Natarajan & Koland.) Y.C. Dai (Natarajan & Kolandavelu 1993), *H. papyraceus* (Schwein.) Y.C. Dai & Niemelä (Ryvarden & Johansen 1980), and *H. tuberculosus* (Fr.) Niemelä & Y.C. Dai (Ryvarden & Gilbertson 1994), but the spores of these latter three species are distinctly narrower (less than 8 µm in width), and they are hyaline rather than pale yellowish. In addition, mature basidiocarps of these three species are more than 2 mm thick.

Key to worldwide species of *Haploporus*

(Statistical variation of spore dimensions is included for each species)

1. Basidiospores < 7 µm in length 2
1. Basidiospores > 7 µm in length 3
2. Basidiocarps pileate, with a strong anise odour when fresh, known from circumboreal forests *H. odoratus* (Sommerf.) Bondartsev & Singer
(4–)4.5–6(–6.5) × (3.1–)3.7–4.6(–5.5) µm,
L = 5.18 µm, W = 4.05 µm, Q = 1.24–1.32 (n = 120/4)
2. Basidiocarps resupinate, without any odour when fresh, known from tropical African forests *H. nanosporus* (A. David & Rajchenb.) M. Piątek
(4.3–)4.5–6(–6.8) × 3–4 µm,
L = 5.33 µm, W = 3.39 µm, Q = 1.51–1.63 (n = 60/2)
3. Basidiospores mostly > 8 µm wide, on gymnosperm *H. latisporus*
13–16.5(–17) × (7.5–)8–10 µm,
L = 14.3 µm, W = 8.67 µm, Q = 1.64–1.66 (n = 80/2)
3. Basidiospores mostly < 8 µm wide, on angiosperm 4
4. Basidiocarps perennial, > 5 mm thick when mature, known from temperate forests .5
4. Basidiocarps annual, < 3 mm thick when mature, known from subtropical and tropical forests 7
5. Pores 1–2 per mm; skeletal hyphae dextrinoid *H. tuberculosus*
(9.9–)10.5–14.8(–15) × (5.1–)5.3–7.9(–8) µm,
L = 12.3 µm, W = 6.35 µm, Q = 1.94 (n = 73/2)
5. Pores 3–4 per mm; skeletal hyphae non-dextrinoid 6
6. Generative hyphae scanty in subiculum; skeletal hyphae partly amyloid
..... *H. subtrameteus* (Pilát) Y.C. Dai & Niemelä
(7.9–)8.1–11(–13.7) × (4.7–)4.8–6.3(–6.8) µm,
L = 9.42 µm, W = 5.5 µm, Q = 1.68–1.75 (n = 60/2)
6. Generative hyphae abundant in subiculum; skeletal hyphae IKI– *H. thindii*
(10.4–)10–16 × (5.1–)6–7(–7.2) µm,
L = 13.38 µm, W = 6.27 µm, Q = 2.11–2.15 (n = 60/2)
7. Pores 4–5 per mm; dendrohyphidia present at dissepiment edges
..... *H. alabamiae* (Berk. & Cook) Y.C. Dai
(8–)8.3–12.5(–12.9) × (4–)4.2–6.8(–7) µm,
L = 10.49 µm, W = 5.54 µm, Q = 1.84–1.98 (n = 60/2)
7. Pores 2–3 per mm; dendrohyphyphidia absent *H. papyraceus*
(10.5–)11–15(–15.1) × (5.5–)5.6–7(–7.4) µm,
L = 12.56 µm, W = 6.25 µm, Q = 1.92–2.11 (n = 60/2)

Specimens examined. — *H. alabamiae*. China. Hainan Prov., Ledong County, Jianfengling Nat. Res., on angiosperm twig, 21.XI.2002 Dai 4363 (IFP). Jiangxi Prov., Wuyishan Nat. Res., 6.VII.1994 Abe (IFP, dupl.). Sichuan Prov., Ermeishan County, Ermei Mts., on fallen angiosperm branch, 19.X.2002 Dai 4285 (IFP). USA. Florida, Gainesville, H.W. Ravenel

Fungi Amer. Exs 110 (isotype, K). — *H. nanospora*. Gabon. Makokou, 5.V.1976 LYAD 2044 (BAFC). Libreville, 20.XI.1977 LYAD 2368 (BAFC). 5.V.1976 LYAD 2044 (BAFC). — *H. odoratus*. China. Heilongjiang Prov., Yichun County, Fenlin Nat. Res., on living tree of *Syringa*, 8.IX.2002 Dai 3673 (IFP). Hubei Prov., Shengnongjia Nat. Res., Jinhoulng Mts., on fallen angiosperm trunk, 5.IX.2005 Dai Li 595 (IFP). Jilin Prov., Antu County, Changbaishan Nat. Res., on dead tree of *Syringa*, 7.IX.1993 Y.C. Dai 1138; Dunhua County, Huangnihe, on rotten wood of *Salix*, 8.VIII.1997 Dai 2303 (IFP). Shannxi Prov., Mei County, Taibaishan Nat. Res., on living tree of *Salix*, 5.VIII.2006 Dai 7665 (IFP). Finland. Koillismaa, Oulanka National Park, on living tree of *Salix*, 18.IX.1997 Dai 2693 & Niemelä (IFP). — *H. papyraceus*. China. Hubei Prov., Shengnongjia Nat. Res., Jinhoulng Mts., on fallen angiosperm branch, 24.IX.2004 Dai 5865 (IFP). Guangdong Prov., Huidong County, Gutian, on dead branch of living *Rosa*, 24.IX.1986 Zheng 11078 (GDGM). Sichuan Prov., Aba County, Jiuzhaigou Nat. Res., dead tree of *Betula*, 12.X.2002 Dai 4052 (IFP). Taiwan, Pingtung, Payuchi, on angiosperm branch, 18.I.1995 Chen 265 (IFP). USA. North Carolina, Durham, Duke Forest, on muscadine grape stem, 24.XII.1946 Wolf (H). — *H. subtrameteus*. China. Liaoning Prov., Qingyuan County, Dasuhe Forest Farm, on rotten angiosperm trunk, 23.X.2003 Wei 1180 (IFP). Russia. Primorye Terr., Teruci, Sichote-Alinicum, Maisa, on *Padus*, 12.IX.1976 Parmasto (TAA 52498). — *H. thindii*. China. Xizang Autonomous Region, Bayi County, on fallen branch of *Lonicera*, 3.VIII.2004 Dai 5641, Yu & Wang (IFP); on rotten wood of *Lonicera*, 3.VIII.2004 Dai 5651, Yu & Wang (IFP). Linzhi County, Sejila Mts., on dead tree of *Acer*, 31.VIII.2004 Dai 5435, Yu & Wang (IFP). — *H. tuberculosis*. Austria. Ostalpen, Grazer Bergland, Steiermark, *Quercus*, 30.III.1978 Riedl (H). Sweden. Halland, Släp, Särö Västerskog, on dead branches of *Quercus*, 20.VIII.1996 Dai 2252 & Niemelä (H); 6.X.1970 Niemelä (H).

Acknowledgements

We are grateful to Prof. Nils Hallenberg (GB, Sweden) and Dr. Peter Buchanan (PDD, New Zealand) who reviewed the manuscript. We thank Dr. Mario Rajchenberg (BAFC, Argentina), Prof. Erast Parmasto (TAA, Estonia) and curators of the herbaria of GDGM (China) and K (UK) for loans. Prof. Teuvo Ahti (H, Finland) generously helped with preparing the Latin descriptions and reviewing the manuscript. YCD thanks Dr. Tuomo Niemelä (H, Finland) for his friendly support of his studies in various ways at Botanical Museum of University of Helsinki. The research is supported by the Ministry of Science and Technology of China (Project No. 2005DFA30280).

Literature cited

- Anonymous. 1969: Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London.
- Dai YC, Li TH. 2002: *Megasporoporia major* (Basidiomycota), a new combination. *Mycosystema* 21: 519–521.
- Dai YC, Niemelä T, Kinnunen J. 2002: The polypore genera *Abundisporus* and *Perenniporia* (Basidiomycota) in China, with notes on *Haploporus*. *Ann. Bot. Fennici* 39: 169–182.
- Hattori T. 2002: A list of Polypores (*Basidiomycotina*, *Aphylllophorales*) collected in Jumna, Nepal. *Bulletin of the National Science Museum. Series B (Botany)* 28 (2): 27–38.
- Kotlaba F, Pouzar Z. 1963: A new genus of the polypores — *Pachykytospora* gen. nov. *Česká Mykol.*

17: 27–34.

- Natarajan K, Kolandavelu K. 1993: A new species of *Pachykytospora* Kotl. et Pouz. from India. *Crypt. Bot.* 3: 195–196.
- Petersen JH. 1996: Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.
- Piątek M. 2005: Taxonomic position and world distribution of *Pachykytospora nanospora* (*Polyporaceae*). *Ann. Bot. Fennici* 42: 23–25.
- Ryvarden L, Gilbertson RL. 1994: European polypores 2. *Synopsis Fungorum* 7: 394–743.
- Ryvarden L, Johansen I. 1980: A preliminary polypore flora of East Africa. *Fungiflora*, Oslo. Norway. 1–636 pp.

**A new species of *Hygroaster*
(*Hygrophoraceae*, *Agaricales*) from Colombia**

ANA ESPERANZA FRANCO-MOLANO¹
& CARLOS ALBERTO LÓPEZ-QUINTERO²

afranco@quimbaya.udea.edu.co¹ & carpez99@yahoo.com²
Laboratorio de Taxonomía y Ecología de Hongos
Instituto de Biología, Universidad de Antioquia
A.A. 1226, Medellín, Colombia

Abstract—A new taxon of *Hygroaster* is proposed as *H. cleefii*. The collections representing this species were found in tropical lowland forests in the Departments of Caquetá and Chocó and on the Gorgona Islands of Colombia. The small size, the dark color of the basidiocarps and the translucent pileus surface are the macroscopic features that characterize this species. *Hygroaster cleefii* has smaller spores with longer spines than the other darkly pigmented species, *H. nodulisporus*. The presence of clamp connections differentiates *H. cleefii*, from the neotropical species of the genus.

Key words—dipterocarp forest, *Hygrocybe*, *Hygrophorus*, *Omphaliaster*.

Introduction

The genus *Hygroaster* Singer belongs to the family *Hygrophoraceae*, and was segregated from the genus *Hygrophorus* based on the spore morphology and the combination of the presence of divergent lamellar trama and hyphae without clamp connections (Singer 1955). The genus was emended by Ludwig (1997) to include species having clamp connections and subregular hymenophoral trama. Based on the Index fungorum list (<http://www.indexfungorum.org/Names/Names.asp>), the genus contains six species: *H. nodulisporus*, *H. albellus*, *H. lacteus*, *H. iguazuensis*, *H. agumbensis*, and *H. trachysporus*.

Hygroaster nodulisporus (Dennis) Singer, described from Trinidad (a continental island between Venezuela and the Lesser Antilles), is the type species of the genus and is characterized by having medium-sized basidiocarps and inamyloid, subglobose and stellate spores, $8.5\text{--}11 \times 7.5\text{--}9.5 \mu\text{m}$, with ornamentation consisting of obtuse conical spines up to $1.5 \mu\text{m}$ long (Singer 1955, Pegler 1983). *Hygroaster albellus* Singer, described from Brazil, is a white species characterized by having small basidiocarps and spores $10\text{--}14 \times 9.5\text{--}$

13.5 μm , with ornamentation consisting of conical and acute spines up to 3.5 μm long (Singer 1989). *Hygroaster lacteus* E. Ludw. & Ryberg, described from Sweden, is also a white species characterized by having globose to ellipsoid and nodulose spores of $7\text{--}10.5(-12) \times 7\text{--}10.5 \mu\text{m}$ (including ornamentation), subregular hymenophoral trama, and clamp connections (Ludwig 1997). The most deviant species are *H. iguazuensis* B.E. Lechner & J.E. Wright, recently described from subtropical Argentina, which is characterized by having small and bright orange basidiocarps and polygonal nodulose spores of $5\text{--}7 \times 3.7\text{--}4.5 \mu\text{m}$ (Lechner et al. 2005), *H. agumbensis* Sathe and S.M. Kulk., described from India, characterized by having pale vinaceous brown pileus and nodulose or angular spores of $6\text{--}9 \times 5\text{--}7.5 \mu\text{m}$ (Sathe & Kulkarni 1980), and *H. trachysporus* Z.S. Bi, described from China, characterized by having yellow to pinkish basidiocarps, rugulose spores of $(9\text{--})11\text{--}13(-16) \times 6.5\text{--}7.2(-8.5) \mu\text{m}$, irregular hymenophoral trama and clamp connections (Bi & Li 1988).

Methods

Specimens were collected, documented, photographed, and dried according to Halling (1996), Lodge et al. (2004), and Franco-Molano et al. (2005). Color designations within parentheses are from Kornerup & Wanscher (1983). Line drawings were made with the aid of a drawing tube. All micromorphological structures were measured in 3% KOH. Letter abbreviation describing basidiospore size are n = number of spores measured, Q = mean length/width ratio.

Taxonomy

Hygroaster cleefii Franco-Molano & López-Quintero sp. nov.

MYCOBANK # MB510469

Figs. 1 & 2.

Hygroaster cleefii, species distinguenda ab aliis speciebus generis basidiomatibus parvis, obscure olivaceo-brunneis vel brunneo-griseis translucetibus et fibulis praesentibus.

Etymology: Named after Antoine Cleef, who has supported the Botanical and Mycological Research in the Middle Caquetá of Colombia by funding support through international programs for studies in tropical areas.

COLOMBIA. DPTO CAQUETA: Araracuara about 50 km downstream on the Río Caquetá, near Peña Roja, ca $0^{\circ} 34' \text{ S}$, $79^{\circ} 08' \text{ W}$ at 200–300 m elevation, 3 Sep. 1999, Carlos Lopez-Q. 226 (**Holotype:** HUA). DPTO DE CHOCO: Municipio of Istmina, along of Panamerican Highway, 5 km W of Puerto Nuevo, 13 May 1991, Ana E. Franco-M. 651 (**Paratype:** HUA). PARQUE NATURAL NACIONAL ISLA GORGONA, Margarita Pulido 3330 (**Paratype:** COL).

Pileus: 0.2–1.0 cm in diam., convex to plane-convex, slightly depressed at the center; surface moist, glabrous, translucent, olive-brown (4C4), yellowish brown (5F4) or brownish gray-brown (9F2) overall; margin incurved. **Context:** less than 1 mm thick, concolorous with pileus surface. Odor and taste not

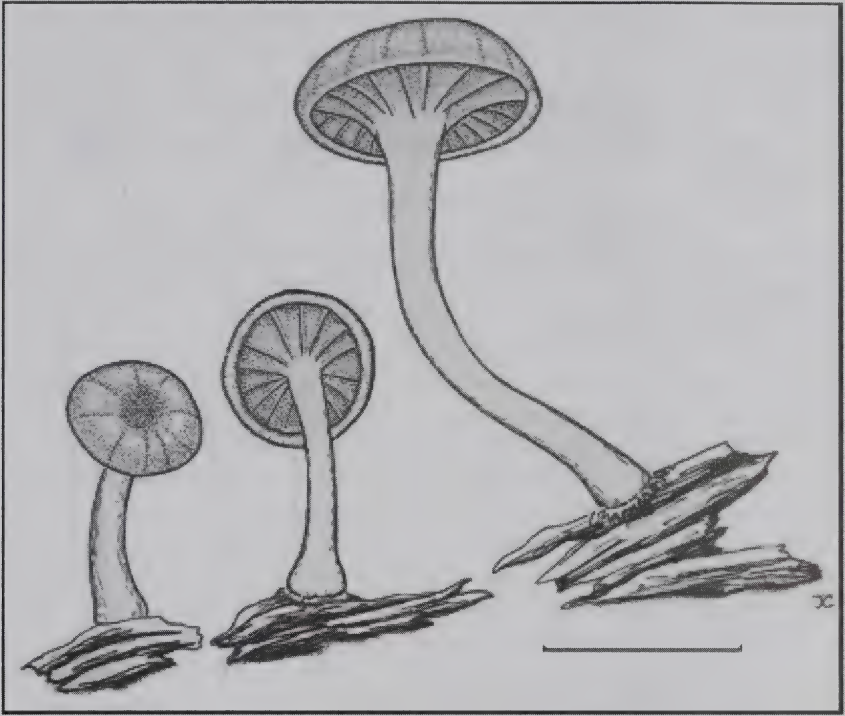


Fig. 1. Habit of *Hygroaster cleefii*. Scale bar = 1 cm.

distinctive. **Lamellae:** up to 0.5 mm broad, concolorous with pileus surface, adnate to slightly subdecurrent, distant. **Stipe:** 0.5–1.5 cm in length, up to 0.12 cm diam. near the apex, central, bulbous at base; surface moist, glabrous, translucent, smooth, concolorous with pileus surface. Basal mycelium poorly developed, white if present. Growing on decayed wood.

Spore print: not obtained. **Basidiospores** (Fig. 2a.): $(7-8-10 \times (5.2-5.5-7.2 \mu\text{m}))$ ($n = 25$, $Q = 1.35 \mu\text{m}$), broadly ellipsoid to subglobose, hyaline in KOH, inamyloid in Melzer's reagent, acyanophilic in Cotton blue; ornamentation consisting of broad conical spines with blunt apices up to $3.2 \mu\text{m}$ long. **Basidia** (Fig. 2b): $44-65 \times 6.5-12 \mu\text{m}$, subcylindric to narrowly clavate, four-sterigmate. **Hymenial cystidia:** absent, but sterile, cylindrical to capitate cells, $13.5-17 \times 3.2-5.6 \mu\text{m}$ are often observed (Fig. 2c). **Hymenophoral trama:** divergent from a mediostratum. The mediostratum is composed of parallel hyphae up to $12 \mu\text{m}$ wide giving rise to diverging hyphae, slightly gelatinized. **Subhymenium:** poorly differentiated. **Pileipellis** (Fig. 2d): formed by an epicutis of subparallel to interwoven hyphae embedded in a gelatinized matrix; hyphae cylindrical to inflated, $5-11.5 \mu\text{m}$ wide, thin-walled, and frequently filled with light brown

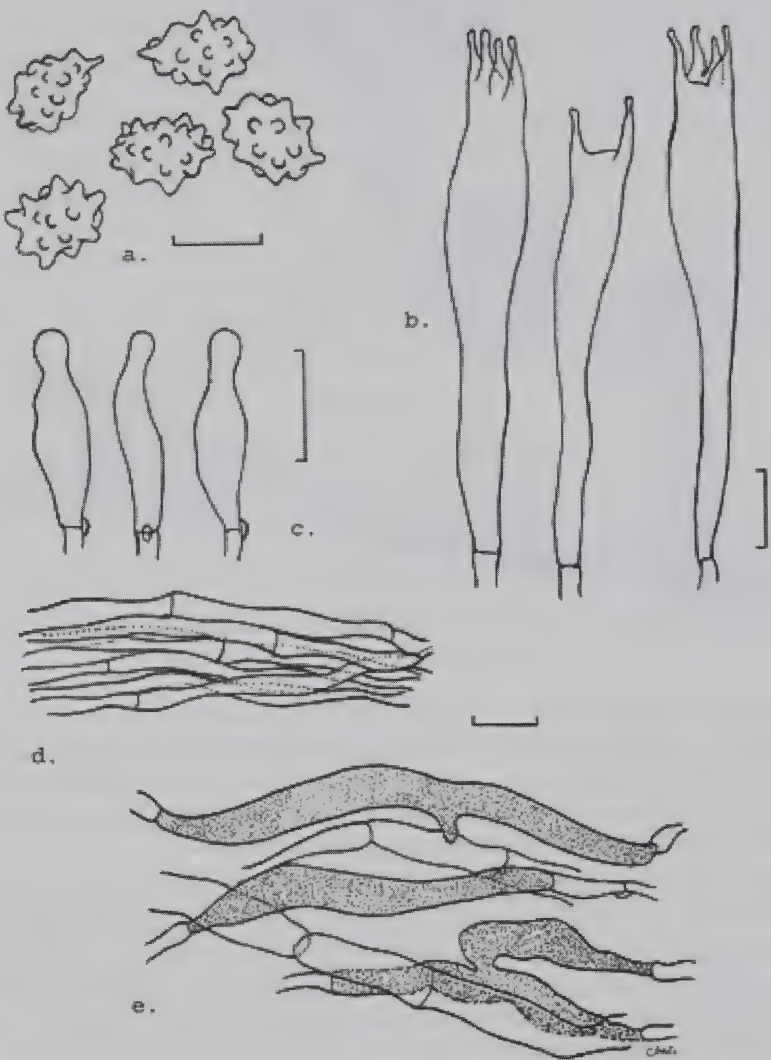


Fig. 2. Microscopic features of *Hygroaster cleefii*.
a. Spores; b. Basidia; c. Hymenial sterile cells; d. Hyphae of pileipellis; e. Oleiferous elements.
Scale bars 10 μ m.

content. **Pileal trama:** of interwoven, cylindrical to inflated hyphae, 3.2–12 μm in wide, thin-walled, often branched. Oleiferous elements (Fig. 2e) present but not abundant, sparingly branched and refractive in KOH mounts. **Stipitipellis:** composed of vertically oriented and parallel cylindrical hyphae; hyphae 3.2–7.2 μm wide, thin walled. **Clamp connections:** frequently present.

Discussion

Hygroaster has a tropical and subtropical distribution in the Americas and Asia; the species described from Europe probably belongs somewhere else. *Hygroaster cleefii* constitutes the seventh member for the genus. The proposed species shares with others in the genus most of the macroscopic and microscopic features but differs from them in the combination of small, dark, and translucent basidiocarps, divergent hymenophoral trama and the presence of clamp connections. Besides the combination of size and color of the basidiocarps, *Hygroaster cleefii* can be differentiated from other species of *Hygroaster* by spore size and ornamentation. *Hygroaster cleefii* has smaller spores and longer spines than the other darkly pigmented species, *H. nodulisporus*. The spores of *H. cleefii* are smaller than those of *H. albellus* and have blunt vs. the acute spines in the latter species. *Hygroaster lacteus* also with clamp connections, differs from *H. cleefii* in having white basidiocarps and globose and bigger spores but the former species probably belongs to *Omphaliaster* due to its subparallel hymenophoral trama and because it was growing on mosses. Spores of *H. iguazuensis* are smaller than those of *H. cleefii*, are more elongated, and have a polygonal outline. Spores of *H. iguazuensis* more closely resemble those of spiny-spored forms of *Hygrocybe anomala* from Australia (Young 2005) and *H. insipida* from Europe (Boertmann 1995). Furthermore *Hygroaster iguazuensis* has bright orange basidiocarps, more suggestive of *Hygrocybe* than *Hygroaster*. *Hygroaster trachysporus* with bigger and rugulose spores of $(9\text{--})11\text{--}13 \times 6.5\text{--}7.2\text{--}(8.5) \mu\text{m}$, numerous cheilocystidia and big, yellow to pinkish and glutinous basidiocarps, probably also belongs to *Hygrocybe*. The other species of *Hygroaster*, *H. agumbensis* with pale vinaceous brown pileus, and nodulose or angular spores of $6\text{--}9 \times 5\text{--}7.5 \mu\text{m}$ is a dubious species poorly described and illustrated that probably belongs to a genus within *Entolomataceae*.

Hygroaster is closely related to *Omphaliaster* Lamoure (Singer 1986) however there are differences between these two genera. The *Hygroaster* species are characterized by their macroscopic appearance to other members of *Hygrophoraceae* and because microscopically the species of this genus have divergent and somewhat gelatinized hymenophoral trama and lack pseudocystidia. Furthermore, basidiocarps of species of *Hygroaster* seem to be restricted to tropical areas growing on soil or on decaying wood. Members of *Omphaliaster* are characterized by an omphalinoid habit with dry pileus surface.

Microscopically the species of this genus are characterized by having regular to irregular not gelatinized hymenophoral trama and by having pseudocystidia as a prolongation of the conducting system into the hymenium. *Omphaliaster* seems to be a temperate to boreal genus and its members grow associated with mosses.

Key to Neotropical species of *Hygroaster*

1. Clamp connections absent. 2
1. Clamp connections present. 3
2. Basidiocarps medium sized and pileus darkly pigmented; spores stellate, $8.5\text{--}11 \times 7.5\text{--}9.5 \mu\text{m}$, with ornamentation consisting of obtuse conical spines up to $1.5 \mu\text{m}$ long. *H. nodulisporus*
2. Basidiocarps small and white overall; spores $10\text{--}14 \times 9.5\text{--}13.5 \mu\text{m}$, with ornamentation consisting of conical and acute spines up to $3.5 \mu\text{m}$ long. *Hygroaster albellus*
3. Basidiocarps small and darkly pigmented; spores $8\text{--}10 \times 5.4\text{--}7.2 \mu\text{m}$ with an ornamentation consisting of broad conical spines with blunt apices up to $3.2 \mu\text{m}$ long. *H. cleefii*
3. Basidiocarps small and white; spores of $7\text{--}10.5\text{--}(12) \mu\text{m}$ (including ornamentation), ornamentation consisting of broad conical spines with blunt apices up to $2.3\text{--}(3) \mu\text{m}$ long. *H. lacteus*
(probably an *Omphaliaster*, not found in the Neotropics)

Acknowledgments

Work in Amazon region of Colombia was possible due to the support of Instituto de Biología de la Universidad de Antioquia and NWO and WOTRO grant WB 84-525 to Dr. Teun Boekhout (CBS, Utrecht, The Netherlands). The authors wish to acknowledge Eladio Moreno and family and Oliverio Rodriguez and family who actively collaborated in the field. Thanks are extended to Drs. Teun Boekhout, Roy Halling, Timothy Baroni, and Jean Lodge for their help and the critical review of the manuscript, and to Dr. Walter Gams for the translation of the diagnosis into Latin. The habit of *Hygroaster cleefii* was drawn by Jhon Jairo Colorado.

Literature cited

- Bi Z-s, Li T-h. 1988. Two new species of agarics from north Guangdong province of China. Bull. Bot. Res. 8: 97-102.
- Boertmann D. 1995. The genus *Hygrocybe*. Fungi of Northern Europe Vol. 1. 184pp.
- Dennis RWG. 1953. Some West Indian collections referred to *Hygrophorus*. Kew Bull. 1953: 259.
- Franco-Molano AE, Vasco-P AM, López-Q CA, Boekhout T. 2005. Macrohongos de la Región del Medio Caquetá – Colombia. Guía de campo. Multimpresos Ltda., Medellín, Colombia. Pp. 211.

- Halling RE. 1996. Recommendations for collecting mushrooms. Pp. 135-141. In: M.N. Alexiades (ed.). Selected guidelines for ethnobotanical research: A field manual. The New York Botanical Gardens. Bronx, NY. USA.
- Kornerup A, Wanscher J. 1983. Methuen handbook of colour. 3rd ed. Eyre Methuen. London. 252p. 30 pl.
- Lechner BE, Wright JE, Popoff OF. 2005. *Hygroaster iguazuensis* sp. nov. and a new continental record for *Lentinus similis*. Mycotaxon 91: 9-14.
- Lodge D, Ammirati JF, O'Dell TE, Mueller GM. 2004. Collecting and describing macrofungi. 128-158 pp. In: Mueller GM, Bills GE, Foster MS. (eds). Biodiversity of fungi. Inventory and monitoring methods. Elsevier Academic Press,
- Ludwig E. 1997. Ein neuer Sternsporling – *Hygroaster lacteus* und die Gattungen *Hygroaster*/*Omphaliaster* aus heutiger Sicht. Z. Mykol. 63: 155 – 162.
- Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Kew Bull. Add. Ser. 9: 43-44.
- Sathe AV, Kulkarni SM. 1980. *Agaricales* (Mushrooms) of South West India (Pune). Maharashtra Association for Cultivation of Science 1:43-73
- Singer R. 1955. Type studies on Basidiomycetes. Sydowia 9: 367-431.
- Singer R. 1986. The *Agaricales* in modern taxonomy. Königstein, Koeltz Scientific Books. Germany.
- Singer R. 1989. New taxa and new combinations of *Agaricales* (Diagnoses Fungorum Novorum Agaricalium IV). Fieldiana 21: 6-7.
- Young AM. 2005. Fungi of Australia: *Hygrophoraceae*. ABRS, Canberra; CSIRO Publishing, Melbourne. 179 p.

Two new records of *Entyloma* (*Entylomatales*) from China

SHUANGHUI HE^{1,2} & LIN GUO^{1*}

heshh1981@hotmail.com *guol@sun.im.ac.cn

¹Key Laboratory of Systematic Mycology and Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

²Graduate University of Chinese Academy of Sciences
Beijing 100049, China

Abstract—A new Chinese record, *Entyloma ranunculi-repentis* on *Ranunculus japonicus*, and a new Asian record, *Entyloma erodii* on *Geranium* sp. are described. These specimens were collected in Xinjiang Uygur Autonomous Region, Northwestern China.

Key words—*Ustilaginomycetes*, smut fungi, taxonomy

A specimen of *Entyloma* on *Ranunculus japonicus* was collected from Xinjiang Uygur Autonomous Region, Northwestern China in 2003. This species is parasitic on the leaves, causing round or angular spots. The host plant belongs to the family *Ranunculaceae*. So far, 5 species of the genus *Entyloma* on *Ranunculus* have been recognized: 1) *Entyloma microsporum* (Unger) J. Schröt. (Rabenhorst 1874), 2) *Entyloma ficariae* A.A. Fisch. Waldh. (Fischer von Waldheim 1877), 3) *Entyloma verruculosum* Pass. (Passerini 1877), 4) *Entyloma ranunculi-repentis*, and 5) *Entyloma ameghinoi* Speg. (Spegazzini 1902). The specimen from China is identified as *Entyloma ranunculi-repentis*, which is new to China.

Entyloma ranunculi-repentis Sternon, L'hétérogenité du genre *Ramularia* p. 34, 1925. Figs. 1-2

Sori in leaves as round or angular spots, 1–5 mm in diam., pale yellow. Ustilospores globose, subglobose, ovoid, sometimes slightly irregular, 8–15 x 8–12.5 µm, light yellowish-brown; wall smooth, even, 1–1.5(–2) µm thick.

Specimen examined—On *Ranunculus japonicus* Thunb. (*Ranunculaceae*), Xinjiang: Burqin, Hemuxiang, alt. 1100 m, 15 VIII 2003, L. Guo & H.C. Zhang 2148, HMAS 161138.

*corresponding author

Entyloma ranunculi-repentis is similar to *Entyloma ficariae* from which it differs in the smaller ustilospores and thinner walls, while *Entyloma ficariae* has larger ustilospores, 10.5–16(–20) x 10–14.5 µm and thicker walls, 1–2.5(–3) µm (Vánky 1994).

A specimen of *Entyloma* on *Geranium* sp. was collected from Xinjiang Uygur Autonomous Region, Northwestern China in 2003. This species is parasitic on leaves, causing round or irregular spots. The host plant belongs to *Geraniaceae*. So far, only two species of *Entyloma* have been recognized on *Geraniaceae* in the world: *Entyloma erodii* on *Erodium laciniatum* Willd. distributed in Tunisia and *Entyloma atlanticum* Massenot on *Geranium* distributed in North Africa and Southwest Asia. The specimen of China is identified as *Entyloma erodii*, which is new to China and Asia. It is the first smut species on the family *Geraniaceae* from China.

Entyloma erodii Vánky, Mycotaxon 40: 159, 1991.

Figs. 3–4

Sori in leaves, forming round, irregular, slightly pustular, pale brown spots, 1–5 mm in diam. Ustilospores most globose, subglobose, ovoid, ellipsoid, sometimes subpolygonally irregular, 8–14.5 x 7.5–12.5 µm, subhyaline or pale yellowish-brown; wall smooth, most evenly thickened, a few unevenly thickened at the angles, 0.5–1(–1.5) µm.

Specimen examined—On *Geranium* sp. (*Geraniaceae*), Xinjiang: Yining, Qapqal, alt. 520 m, 13 VIII 2003, L. Guo & H.C. Zhang 2213, HMAS 162296.

According to Vánky (2002) about 180 species of *Entyloma* have been found on plants belonging to 25 families. Tai (1979) listed 7 *Entyloma* species in China, but two of them have recently been shown to belong to other genera: *Entyloma oryzae* Syd. & P. Syd. (= *Eballistra oryzae*; Bauer et al. 2001) and *Entyloma eleocharidis* L. Ling (= *Jamesdicksonia eleocharidis*; Vánky 2004). So far, only 7 species (including the two species reported in this paper) of *Entyloma* have been recognized in China. They are *Entyloma australe* Speg., *Entyloma compositarum* Farl., *Entyloma dahliae* Syd. & P. Syd., *Entyloma guaraniticum* Speg. and *Entyloma microsporium*. Certainly, there are many *Entyloma* species still to be discovered from China.

Acknowledgements

The authors would like to express their deep thanks to Drs. Vánky and Begerow for reading the manuscript and serving as pre-submission reviewers, to Dr. Pennycook for nomenclatural review, to Professor Liu Shurun for identifying the host plants, and to

Figs. 1–2. *Entyloma ranunculi-repentis* on *Ranunculus japonicus* (HMAS 161138). Fig. 1. Sori. Fig. 2. Ustilospores as seen by LM (light microscopy). Figs. 3–4. *Entyloma erodii* on *Geranium* sp. (HMAS 162296). Fig. 3. Sori. Fig. 4. Ustilospores as seen by LM.



Ms. Li Zhenying for dealing with the plate. This study was supported by the National Natural Science Foundation of China (No. 30230020).

Literature cited

- Bauer R, Begerow D, Nagler A, Oberwinkler F. 2001. The *Georgenfischeriales*. a phylogenetic hypothesis. Mycol. Res. 105: 416-424.
- Fischer von Waldheim. 1877. Zur Kenntniss der *Entyloma*-Arten. Bull. Soc. Nat. Imp. Naturalistes Moscou. 52: 306-311.
- Passerini G. 1877. Funghi Parmensi. Nuovo Giorn. Bot. Ital. 9: 235-267.
- Rabenhorst L. 1874. Fungi europaei exs. Cent. XIX. No.1801-1900.
- Spegazzini C. 1902. Mycetes argentinenses (Series II). Anales Mus. Nac. Buenos Aires, Ser. 3, 1: 47-89.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing, 1527 pp.
- Ványk K. 1994. European Smut Fungi. Gustav Fischer Verlag Stuttgart, Jena, New York. 570 pp.
- Ványk K. 2002. Illustrated Genera of Smut Fungi. The American Phytopathological Society St. Paul, Minnesota. 238 pp.
- Ványk K. 2004. Taxonomical studies on *Ustilaginomycetes*-24. Mycotaxon 89: 55-118.

New records of pyrenocarpous lichenicolous fungi from Turkey

MEHMET GÖKHAN HALICI*

mghalici@erciyes.edu.tr

Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

AYŞEN ÖZDEMİR TÜRK & MEHMET CANDAN

aturk@anadolu.edu.tr, mecandan@anadolu.edu.tr

Department of Biology, Faculty of Science, Anadolu University
Eskişehir, Turkey

Abstract—This study reports eight species of lichenicolous fungi from Turkey. Five of these taxa, *Endococcus propinquus*, *E. rugulosus*, *Polycoccum cartilagosum*, *P. crassum* and *Stigmidium psorae* are new records for Turkey. The others, *Arthonia epiphyscia*, *Stigmidium tabacinae* and *Weddellomyces turcicus*, are only recorded for the second time from Turkey. Comments on habitat, substrata and ascospore structures are given for each taxon with a short description. More detailed information is given for *Weddellomyces turcicus*, which was described from only one specimen.

Key words—*Ascomycota*, pyrenocarpous fungi, lichens

Introduction

Many fewer taxa of lichenicolous fungi have been reported from Turkey when compared to other countries in Europe (Faltynowicz 2003, Hawksworth 2003, Scholz 2000). Hafellner & John (2006) reported that 63 infrageneric taxa of lichenicolous fungi were known in Turkey. With recent publications that were not included in that paper, the number of lichenicolous fungi taxa reached 68 (Halıcı et al. 2005, 2006). To make contribution for the determination of the lichenicolous fungi flora of Turkey, the part of the lichen collection in the ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey) was reinvestigated with collaboration of MGH. This paper is a result of this study. This contribution reports five more species of lichenicolous fungi as new records for Turkey and three species as second records.

Materials and methods

The specimens are stored in ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey) and their herbarium numbers are given in parentheses after the locality details. The specimens were examined with a Leica MZ6 model stereo, and an Olympus BX51 microscopes. Specimens were examined in water, 10% KOH, Lugols iodine solution or lactofuchsin. Spore measurements were generally carried out in KOH, but in the case of thin walled spores these were also checked in water.

Species recorded

Arthonia epiphyscia Nyl. 1875

Detailed descriptions are provided by Santesson (1960: 500-501), Vězda (1970: 221), Hawksworth (1975: 186) and Alstrup (1981: 121-122).

The specimen was collected from the thallus of *Phaeophyscia orbicularis* on bark of *Pyrus* sp. This species seems to be commensalistic as no damage or discolorations were observed in the host thallus. Ascomata arthonioid, exciple absent, paraphyses branched and anastomosed. Asci broadly clavate, 8-spored. Ascospores all 1-septate, hyaline, 10–13 × 4–5 µm diam. Hypothecium dark brown and hymenium I + red (without pre-treatment with K).

In Turkey, previously recorded only from İzmir (Hafellner & John 2006). New record for Manisa province.

Known from Greenland on thalli of *Physcia* spp., *Phaeophyscia* spp., *Caloplaca saxicola*, *Xanthoria parietina* and *Phaeorrhiza nimbose* (Alstrup & Hawksworth 1990) and South America on thalli of *Physcia caesia* (Wedin 1994).

MANISA: Kula, Northwest of Kula Town, 38° 34' N, 28° 38' E, alt. 680 m, on thallus of *Phaeophyscia orbicularis* on *Pyrus* sp., 14 Aug. 2006, M. Candan (ANES 10156).

Endococcus propinquus (Körb.) D.Hawksw. 1979

Detailed descriptions are provided by Hawksworth (1979: 285) and Rambold et al. (1990).

The specimen was collected from the thallus of an unidentified brown crustose lichen. Our specimen of this species seems to be pathogenic as ascomata production is suppressed, but no bleaching or discolorations were observed in the host thallus. According to Alstrup & Hawksworth (1990), the host apothecia of lichens which are infected by this species may be suppressed. Our observation confirms this data. Ascomata perithecioid, ~200 µm. Wall around ostium has brown hyphae over its surface, long celled hyphae. Hamathecium with broad periphysoids. Asci 8-spored, ascospores 1-septate, brown, 9–11 × 6–7 µm diam, spore wall with a smooth epispore.

New record for Turkey. Known also from Europe, Greenland and N. America on a wide range of crustose, saxicolous lichens (Alstrup & Hawksworth 1990) and worldwide in suitable habitats on *Amygdalaria*, *Koerberiella*, *Porpidia* and *Stenhammarella* (Rambold et al. 1990).

ADIYAMAN: Sincik, Southwest of Sincik, 38° 01'04" N, 38° 37'14" E, alt. 1300 m, on an unidentified brown crustose lichen on calcareous rocks, 29 Jul. 2004, M. Candan (ANES 10157).

Endococcus rugulosus (Borrer ex Leight.) Nyl. 1855

A detailed description is provided by Hawksworth (1979: 287-288).

The specimen was collected from the thallus of an unidentified *Aspicilia* which shows a K – reaction, on siliceous rocks. This species seems to be pathogenic as apothecia production is suppressed in the host lichen and also bleaching is observed in the infected areas of the host thallus. Ascomata perithecia; ± immersed, 180–220 µm diam. Asci 8-spored, ascospores with both ends rounded and not constricted at the septum, 11–15(–16) × 5–7 µm.

New record for Turkey. Known worldwide on a wide range of saxicolous, crustose species (Alstrup & Hawksworth 1990).

MALATYA: North of Tokluca Village, 38° 17'38" N, 38° 31'04" E, alt. 1104 m, on thallus of *Aspicilia* sp. on siliceous rocks, 24 Aug. 2003, M. Candan (ANES 10158).

Polycoccum cartilagosum (Arnold) D.Hawksw. 1985

A detailed description is provided by Hawksworth & Diederich (1988: 297).

The specimen grows on the thallus of *Acarospora cervina*. It seems to be commensalistic as no damage, bleaching or discolorations were observed in the host thallus. Ascomata perithecia; immersed in the host thallus and ~ 200 µm diam. Hamathelial gelatine I –. Asci 8-spored first, 4-spored when mature, ascospores dark brown, 1-septate, verruculose, 27–33 × 8–9 µm.

New record for Turkey. Known also from Italy on an unknown host (Hawksworth & Diederich 1988).

MALATYA: Hekimhan, East of kurşunlu Village, 38° 40' N, 37° 52' E, alt. 1820 m, on thallus of *Acarospora cervina* on calcareous rocks, 19 Aug. 2005, M. Candan (ANES 9837).

Polycoccum crassum Vězda 1970

A detailed description is provided by Hawksworth & Diederich (1988: 300).

The specimen was collected from the lower side of *Peltigera* sp. thallus. It seems to be commensalistic as no damage, bleaching or discolorations were observed in the host thallus. Ascomata erumpent, obpyriform, ~ 400 µm diam. Hymenial gelatine I + orange-red. Asci 4-spored, ascospores ± uniseriately arranged,

cells $\pm$ equal in size, $25\text{--}30 \times 8\text{--}10\text{ }\mu\text{m}$. 1–2 guttules are often present in the ascospores.

New record for Turkey. Known also from the British Isles, Czechoslovakia and Luxembourg on several *Peltigera* species (Hawksworth & Diederich 1988).

MALATYA: Doğanşehir, near the border of Malatya-Adıyaman Provinces, $37^{\circ} 54' \text{ N}$, $37^{\circ} 48' \text{ E}$, alt. 870 m, on thallus of *Peltigera* sp. on soil, 14 Aug. 2005, leg. M. Candan (ANES 10154).

Stigmidium psorae (Anzi) Hafellner 1984

Detailed descriptions are provided by Triebel (1989) and Calatayud & Triebel (1999).

The specimen was collected from the thallus of *Psora decipiens* growing on gypsum. As the infected parts of the host thallus are bleached, this species seems to be weakly pathogenic despite the reports of this species as commensalistic on the host thalli (Calatayud & Triebel 2003). Ascomata perithecia; globose, $125\text{--}150\text{ }\mu\text{m}$ diam., erumpent. Hymenial gelatine I –, Asci Lugole's I + red (without pre-treatment with K), 8-spored, $49\text{--}52 \times 19\text{--}20\text{ }\mu\text{m}$. Ascospores 1-septate, hyaline, $15\text{--}16 \times 5\text{--}6\text{ }\mu\text{m}$.

New record for Turkey. Known also from Spain and Austria on *Psora crenata*, *P. decipiens* and *P. saviczii* (Calatayud & Triebel 2003).

ANKARA: Polatlı, 129th km of Eskişehir-Ankara highway, alt. 750 m, on thallus of *Psora decipiens* on gypsum, 6 Jul. 2004, A. Türk & V. John (ANES 10144).

Stigmidium tabacinae (Arnold) Triebel 1989

A detailed description is provided by Triebel (1989).

The specimen was collected from thalli of *Toninia sedifolia* on calcareous rocks. The species seems to be commensalistic as no damage was observed in the host thalli. Ascomata perithecia; $65 \times 75\text{ }\mu\text{m}$ diam. Ascospores hyaline, 1-septate, $10\text{--}16 \times 3\text{ }\mu\text{m}$.

In Turkey, previously recorded from İzmir (Hafellner & John 2006). New record for Elazığ and Manisa provinces.

Known also from Spain and Great Britain on thalli of *Toninia tristis*, *T. toepfferii*, *T. sedifolia* and *Lecania olivacea* (Triebel 1989).

ELAZIĞ: Southwest of Hıdırbaba Village, $38^{\circ} 45' \text{ N}$, $39^{\circ} 00' \text{ E}$, alt. 1120 m, on thallus of *Toninia sedifolia* on calcareous rocks, 04 Aug. 2004, M. Candan (ANES 10158).

MANISA: Kula, North of Sandal Village, $38^{\circ} 35' \text{ N}$, $28^{\circ} 34' \text{ E}$, alt. 692 m, on thallus of *Toninia sedifolia* on calcareous rocks, 15 Aug. 2006, M. Candan (ANES 10152).

Weddellomyces turcicus Halıcı & Orange 2005

A detailed description is provided by Halıcı et al. (2005).

The original description of this species was based on only one specimen, collected from the thallus of an unidentified grey placodioid *Acarospora* in Turkey. This species differs from other species of the genus in the asci being 2-spored when mature. Ascospore sizes are given as $50\text{--}55.6\text{--}61\text{--}(69) \times (16.5\text{--})18.5\text{--}19.9\text{--}21.5\text{--}(22) \mu\text{m}$ (Halıcı et al. 2005). The second collection of this species from the thallus of *Acarospora cervina* shows all characteristics of the holotype with 2-spored asci when mature but ascospores are $34\text{--}43 \times 15\text{--}16 \mu\text{m}$. Halıcı et al. (2005) reported that this species is likely to be pathogenic, as it occurs on two small, bleached areas of host thallus. The second collection shows that this species can also be commensalistic as well, because no bleaching was observed in the host thallus.

New record for Malatya province.

MALATYA: South of venk Village, North skirts of Bey (Şılan) Mountain, 38° 19' N, 38° 22' E, alt. 1450 m, on thallus of *Acarospora cervina* on calcareous rocks, 21 Jul.2005, M. Candan (ANES 10146).

Acknowledgements

We would like to thank Prof. David L. Hawksworth and Alan Orange for reviewing this paper, and Dr Paul Diederich for determining and checking some taxa.

Literature Cited

- Alstrup V. 1981. Notes on some lichens and lichenicolous fungi from Greenland. Nord. J. Bot. 1: 120-124.
- Alstrup V, Hawksworth DL. 1990. The lichenicolous fungi of Greenland. Medd. Grøn. Bioscience 31: 1-90.
- Calatayud V, Triebel D. 1999. *Stigmidium neofusceliae* (Dothideales s.l.), a new lichenicolous fungus from Spain. Nova Hedwigia 69: 439-448.
- Calatayud V, Triebel D. 2003. Three new species of *Stigmidium* s. l. (lichenicolous ascomycetes) on *Acarospora* and *Squamarina*. Lichenologist 35: 103-116.
- Faltynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. Biodiversity of Poland 6: 1-435.
- Hafellner J, John V. 2006. Über funde lichenicoler nicht-lichenisierter Pilze in der Türkei, mit einer Synopsis der bisher im Land nachgewiesenen Taxa. Herzogia 19: 155-176.
- Halıcı MG, Orange A, Aksoy A. 2005. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. Mycotaxon 94: 249-252.
- Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13-19.
- Hawksworth DL. 1979. Studies in the genus *Endococcus* (Ascomycotina, Dothideales). Bot. Notiser 132: 283-290.

- Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*), with a key to accepted species. *Trans. Br. Mycol. Soc.* 90: 293-312.
- Hawksworth DL. 2003. The lichenicolous fungi of Great Britain and Ireland: an overview and annotated checklist. *Lichenologist* 35: 191-232.
- Rambold G, Hertel H, Triebel D. 1990. *Koerberiella wimmeriana* (*Lecanorales*, *Porpidiaceae*) and its lichenicolous fungi. *Lichenologist* 22: 225-240.
- Santesson R. 1960. Lichenicolous fungi from northern Spain. *Svensk bot. Tidskr.* 54: 499-522.
- Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. *Schriftenr. Vegetationsk.* 31: 1-298.
- Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. *Bibliotheca Lichenologica* 35: 1-278.
- Vězda A. 1970. Beiträge zur Kenntnis der Flechtenbewohnende Pilze in der Tschechoslowakei III. *Ceská Mykol.* 24: 220-229.
- Wedin M. 1994. New and noteworthy lichenicolous fungi from Southernmost South America. *Lichenologist* 26: 301-310.

Entophlyctis luteolus in the Brazilian Atlantic Rainforest

CARMEN L. A. PIRES-ZOTTARELLI*, ALEXANDRA L. GOMES
& CRISTIANE DE A. NASCIMENTO

*zottarelli@uol.com.br

Instituto de Botânica de São Paulo, Seção de Micologia e Liquenologia
Caixa Postal 4005, São Paulo / SP 01061-970, Brazil

Abstract—We found *Entophlyctis luteolus* on cellulosic baits placed with water and soil samples collected from the Brazilian Atlantic Rainforest. Although we were unable to isolate this species into pure culture because of contaminants, its morphology matches that of the type. We describe and illustrate Brazilian examples of this chytrid, which occurred in 26% of our baited samples, and describe germination of resistant sporangia.

Key words—Brazil, Chytridiomycota, Fungi

Introduction

Entophlyctis luteolus is the most recently described (Longcore 1995) species of the genus *Entophlyctis* A. Fisch., which includes nineteen species (Kirk et al. 2001), some of which may be more properly placed in *Powellomyces* (*Spizellomycetales*) (Longcore et al. 1995) or other chytridialean genera, e.g., “*Entophlyctis* development” (James et al. 2000) and *E. apiculata* (A. Braun) A. Fisch. (Shin et al. 2001) have zoospore features or molecular signatures that place them outside of the *Chytridiaceae*. This species was isolated from moribund plant material collected from aquatic habitats in the states of Maine and Michigan (U.S.A.) (Longcore 1995). The species is characterized by hyaline, spherical zoosporangia that are formed endogenously or exogenously. Zoosporangia usually have two rhizoidal axes, the bases of which are slightly swollen. Zoospores with single lipid globules discharge en masse after the deliquescence of the tip of the discharge tube. Asexually developed resistant sporangia are yellow with smooth walls and granular contents; their germination was not observed (Longcore 1995). As determined by analyses of its combined partial SSU and LSU rRNA gene sequences, *E. luteolus* groups phylogenetically in a clade of cellulosic chytrids within the *Chytridiaceae* sensu Letcher et al. (2005). This species has not been reported since its original

description; we herein record its frequent occurrence from samples collected from the Brazilian Atlantic Rainforest of São Paulo State, Brazil and illustrate the heretofore unreported germination of the resistant sporangia.

Material and methods

We collected water and soil samples from Brazilian Atlantic Rainforest sites in São Paulo State (Reserva Biológica de Paranapiacaba - 23°46'S 46°18'W every three months from November 2003 to November 2004, and monthly from June 2005 to June 2006 from Parque Estadual da Serra da Cantareira - 23° 32'36"S 46°37'59"W. In the laboratory we baited samples with the multiple baiting technique of Milanez (1989) to study the diversity of zoosporic fungi. We identified chytrids with the specific literature (Sparrow 1960, Booth 1971, Karling 1977, Longcore 1995), and have placed slides preserved with lactophenol-cotton blue in the fungal herbarium of the Instituto de Botânica de São Paulo (SP).

Results and Discussion

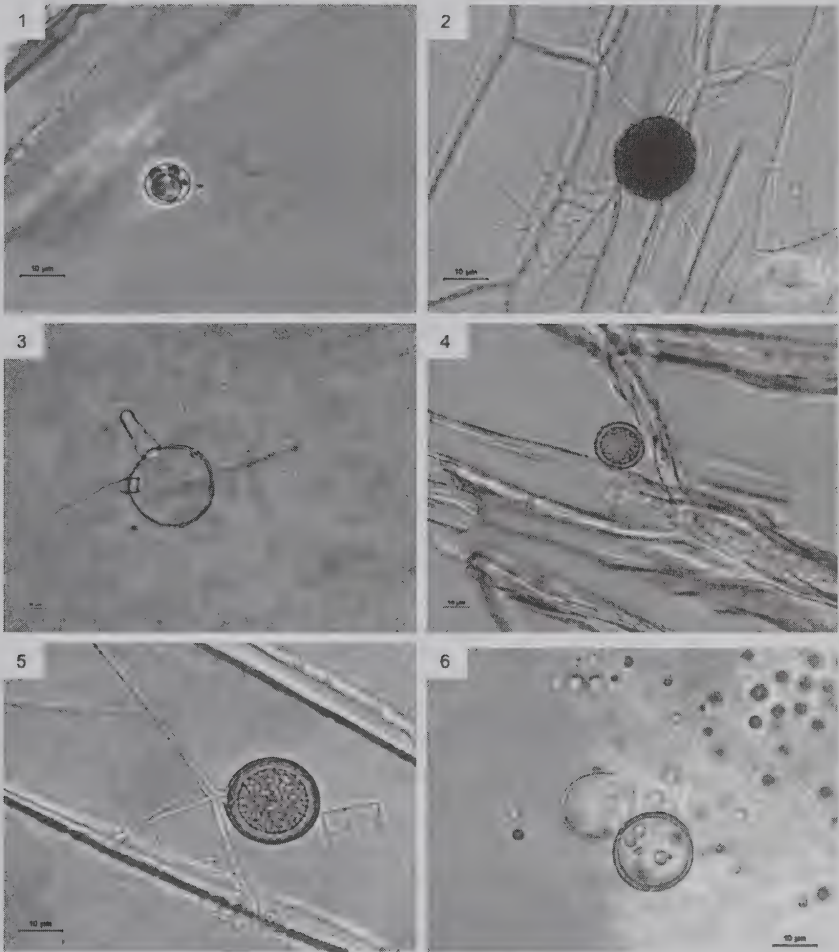
Entophlyctis luteolus specimens grew on cellulosic baits (onion skin and corn straw) and occurred in 69 (26%) of 262 baited water and soil samples. The description of the Brazilian specimens below was based on the organism growing in onion skin used as bait because the presence of contaminants made obtaining pure cultures impossible. In this substrate, zoosporangia and resistant sporangia formed abundantly after one week and rhizoids were easily observed (Figs. 1, 2, 5). The characteristics of rhizoids and zoosporangia agree with those of the original description (Longcore 1995) as do the discharge tubes (Fig. 3), but the inner walls of some resistant sporangia appear irregular. Zoosporangia developed endobiotically and epibiotically on the onion skin and resistant sporangia (Figs. 4, 5) were borne like the zoosporangia. Resistant sporangia functioned as prosperangia during germination and external, thin walled zoosporangia were produced (Fig. 6).

Entophlyctis luteolus Longcore, Mycologia 87(1): 27. 1995.

Figs. 1-6

TYPE: United States (ATCC 90967)

Thallus eucarpic, monocentric, epibiotic or endobiotic. Zoosporangium inoperculate, hyaline, formed endogenously or exogenously, spherical, 15–42.5 (–50) µm in diameter; smooth wall. Zoospores with a single lipid globule, escaping by 1–2 (–4) discharge tubes; encysted zoospore 4–5 µm in diameter. Resistant sporangia borne like zoosporangia, yellow, granular contents, spherical, 15–25 (–35) µm in diameter; outer and inner walls smooth, the inner sometimes irregular. Resistant sporangia function as prosperangia during germination forming external, thin-walled zoosporangia.



Figures 1-6. *Entophlytis luteolus*. 1. Exogenous development. 2. Zoosporangium. 3. Empty zoosporangium with two discharge tubes. 4. Exogenous resistant sporangium. 5. Morphology of an endogenous resistant sporangium. 6. Germination of the resistant sporangium, in which it functions as a prosporangium.

REPRESENTATIVE SPECIMENS EXAMINED— BRAZIL. São Paulo: Santo André, Reserva Biológica de Paranapiacaba, water and soil samples, on onion skin and corn straw, (23°46'78"S 46°18'55"W, 23°46'52"S 46°18'77"W, 23°46'53"S 46°18'75"W, 23°46'53"S 46°18'69"W, 20 November 2003), (23°46'78"S 46°18'55"W, 23°46'52"S 46°18'77"W, 23°46'53"S 46°18'69"W, 23°46'77"S 46°18'56"W, 26 February 2004), (23°46'78"S 46°18'55"W, 23°46'53"S 46°18'75"W, 23°46'52"S 46°18'77"W, 23°46'77"S

46°18'56"W, 26 May 2004), (23°46'78"S 46°18'55"W, 23°46'53"S 46°18'75"W, 23°46'52"S 46°18'77"W, 23°46'53"S 46°18'69"W, 26 August 2004), (23°46'78"S 46°18'55"W, 23°46'52"S 46°18'77"W, 23°46'53"S 46°18'75"W, 18 November 2004); São Paulo, Parque Estadual da Serra da Cantareira, water and soil, on onion skin and corn straw, (20°00'00"S 47°48'75", 08 June 2005, 06 July 2005, 11 August 2005, 21 September 2005, 17 November 2005, 07 December 2005, 26 January 2006, 22 February 2006, 31 March 2006, 19 May 2006), Pires-Zottarelli, C.L.A. SP 381557.

Acknowledgments

We thank FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) and CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for financial support and the Botanical Institute of São Paulo for institutional support. We are grateful to Dr. Joyce E. Longcore and Dr. Peter M. Letcher for reviewing the manuscript.

Literature Cited

- Booth T. 1971. Problematical taxonomic criteria in the *Chytridiales*: comparative morphology of 10 *Entophlyctis* sp. isolates. Canadian Journal of Botany 49: 977–987.
- James TY, Porter D, Leander CA, Vilgalys R, Longcore JE. 2000. Molecular phylogenetics of the *Chytridiomycota* supports the utility of ultrastructural data in chytrid systematics. Canadian Journal of Botany 78: 336–350.
- Karling JS. 1977. Chytridiomycetorum Iconographia: Lubrecht & Cramer, Monticello, New York.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of *Fungi*. 9th ed. CABI Bioscience, Oxon, UK 655 pp.
- Letcher PM, Powell MJ, Chambers JG, Longcore JE, Churchill PF, Harris PM. 2005. Ultrastructural and molecular delineation of the *Chytridiaceae* (*Chytridiales*). Canadian Journal of Botany 83: 1561–1573.
- Longcore JE. 1995. Morphology and zoospore ultrastructure of *Entophlyctis luteolus* sp. nov. (*Chytridiales*): Implications for chytrid taxonomy. Mycologia 87: 25–33.
- Longcore JE, Barr DJS, Désaulniers NL. 1995. *Powellomyces*, a new genus in the *Spizellomycetales*. Canadian Journal of Botany 73: 1385–1390.
- Milanez AI. 1989. Fungos de águas continentais. Pp.17–20 in Técnicas de coleta, preservação e herborização de material botânico (O. Fidalgo & V.L. Bononi, eds.). Instituto de Botânica, São Paulo.
- Skin W, Boo SM, Longcore JE. 2001. *Entophlyctis apiculata*, a chytrid parasite of *Chlamydomonas* sp. (*Chlorophyceae*). Canadian Journal of Botany 79: 1083–1089.
- Sparrow FK. 1960. Aquatic Phycomycetes. 2th ed. University of Michigan Press, Ann Arbor.

Two new species of *Punctelia* (Parmeliaceae) from southern Brazil

LUCIANA S. CANÊZ & MARCELO P. MARCELLI

lucanez@yahoo.com.br

Instituto de Botânica, Seção de Micologia e Liqueenologia
Caixa Postal 4005, São Paulo / SP 01061-970, Brazil

Abstract—During a survey of *Parmeliaceae* species in the area of Fazenda da Estrela, in the municipality of Vacaria, Rio Grande do Sul State, we discovered two new species of *Punctelia*: *P. fimbriata* and *P. purpurascens*.

Key words—*Punctelia constantimontium*, *Punctelia bolliana*, gyrophoric acid, lecanoric acid

Introduction

The genus *Punctelia*, proposed by Krog (1982), is characterized by the pseudocyphellae on the upper surface, filiform or unciform conidia, and the presence of fatty acids, lecanoric acid, or gyrophoric acid in the medulla. Thirty *Punctelia* species have been described (Egan & Aptroot 2004); 16 species are known for Brazil (Marcelli 2004) and 13 for the Rio Grande do Sul State (Spielmann 2006). During a survey of *Parmeliaceae* in the area of Fazenda da Estrela (Canêz 2005), two new species of *Punctelia* were recognized and are formally described here. Fazenda da Estrela, with an area of 287 km², is situated in the Vacaria municipality, which is located on the northern highlands of Rio Grande do Sul State, southern Brazil. *Araucaria angustifolia* (Bertol.) Kuntze forests and natural fields are the predominant vegetational types.

Materials and methods

The specimens were described using standard stereoscopic and light microscopic examination. The anatomical sections, especially of apothecia and pycnidia, were made with razor blade hand sections. Spot tests were performed with potassium hydroxide (K), sodium hypochlorite (C), para-phenylenediamine (P) for all specimens. All taxa were also examined under UV light. Thin-layer chromatography (TLC) was performed using established procedures in solvents A and C (Bungartz 2001), and lichen substances were identified by consulting Huneck & Yoshimura (1996) and Orange et al. (2001).

The diagnosis refers exclusively to the holotype characters and the English descriptions to all the studied material.

The species

Punctelia fimbriata Marcelli & Canêz, sp. nov.

Fig. 1

MYCOBANK MB 510353

Diagnosis: *Affinis Puncteliae constantimontium sed margine fimbriatus, phyllidia irregularia et erecta differt.*

Holotypus– Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela, open field, 28°04'15.9"S, 50°55'11.0"W, 850 m alt., on orange tree trunk in a abandoned farm, leg. L. S. Canêz & A. A. Spielmann 977, 12-I-2004 (SP, isotypes in B and H).

Thallus greenish gray, lobate, 10 cm in diameter; lobes irregularly branched, 1.0–5.0 mm wide, adnate, contiguous, apices rounded, sometimes pruinose, margins crenate to crenulate, with a fimbriate aspect (phyllidiate), elevated, upper surface continuous, smooth; lacinulae absent; maculae weak to distinct, punctiform, laminal; pseudocyphellae white, rounded, rarely ellipsoid, plane, less frequently marginate, 0.05–0.12 (–0.20) mm in diameter, more frequently located in the distal area, becoming densely phyllidiate in the center of the thallus; cilia absent. **Pustulae** absent. **Soralia** absent. **Isidia** absent. **Phyllidia** varying from simple to irregular and coralloid, ascending to erect, 0.2–0.5 × 0.2–0.4 mm, apices round and slightly dissected, distributed on the margins of the lobes and margins of the pseudocyphellae, the older ones becoming corticate below (lobulae) from base to apices. **Medulla** white, pigment absent. **Lower surface** black, shiny to opaque, smooth to slightly papillate; margin pale brown to rarely white, shiny, naked, 0.8–1.5 mm wide, smooth; rhizinae black, frequently with white apices, simple, 0.25–0.80 × <0.05 mm, frequent, evenly distributed. **Apothecia** absent. **Pycnidia** absent.

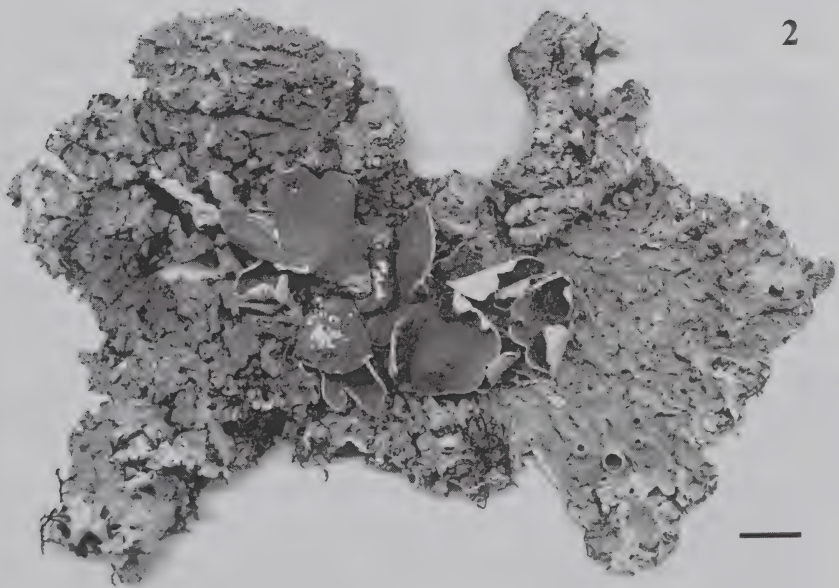
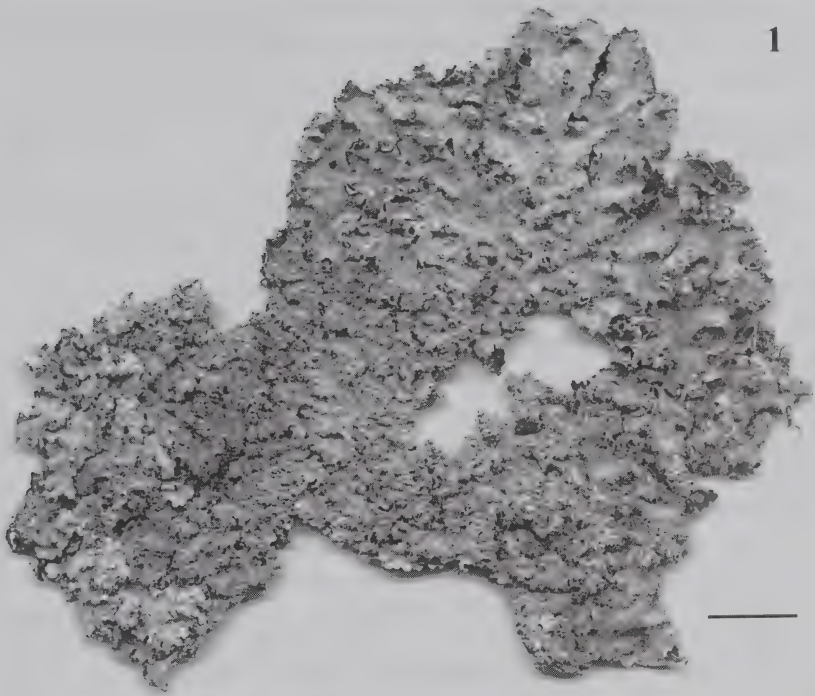
Spot tests: cortex K+ yellow, UV–; medulla K–, C+ rose, KC + rose, P–, UV–.

TLC: traces of atranorin (cortex) and gyrophoric acid (medulla).

Comments– *Punctelia fimbriata* is characterized by the very delicate marginal phyllidia (without lower cortex) that may become lobulate (with lower cortex) when older and so give the margin a fimbriate appearance. Frequently these phyllidia are disposed in a continuous manner and resemble a fringe surrounding the lobes. *Punctelia fimbriata* has a black lower surface and produces gyrophoric acid (C+ rose) in the medulla similar to *P. colombiana* Sérus., which has coralloid isidia. *Punctelia constantimontium* Sérus. is also similar but has phyllidia distributed all over the surface, while *P. stictica* (Del.

Figures 1–2. 1. *Punctelia fimbriata* (holotype). 2. *Punctelia purpurascens* (holotype).

Bars = 10 mm.



ex Duby) Krog produces isidioid soredia. The specific epithet refers to the characteristic phyllidia. This new species is so far known only from the type locality.

***Punctelia purpurascens* Marcelli & Canêz, sp. nov.**

Fig. 2

MYCOBANK MB 510354

Diagnosis: *Thallo ut in Punctelia bolliana sed medulla KOH purpurascens vel pallidus purpureus reagens differt; sporis 13.8–17.5 × 7.5–8.8 µm, conidiis unciformis 3.8–5.0 (–6.0) × 1.0 µm.*

Holotypus—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela, open field, 28°04'01.8"S, 50°57'45.4"W, 920 m alt., on a basaltic rock in a open place, leg. L. S. Canêz & A. A. Spielmann 869, 13-I-2004 (SP, isotype in B).

Thallus green or grayish green, lobate, 10–15 cm in diameter; lobes irregularly branched, 0.7–2.0 (–3.0) mm wide, loosely adnate to adnate, laterally overlapping to crowded in the center, rarely contiguous, apices round, margins crenate, rarely smooth, upper surface continuous, scrobiculate to rugose; maculae absent; pseudocyphellae conspicuous, white, marginate, less commonly plane, punctiform, 0.05–0.15 mm in diameter, or elliptic, and up to 0.3 mm long, restricted to the inter-foveolar ridges and originating cracks in the center of the thallus; cilia absent. **Pustulae** absent. **Soralia** absent. **Lobulae** or **lacinulae** present, appearing as tiny extensions of the lobes margins, 0.3–1.8 × 0.3–2.0 mm. **Medulla** chiefly white, with spots of a yellowish pigment that react K+ pale purple and/or pale orange pigment that react K+ purple, localized more frequently in the distal (marginal) parts of the lobes. **Lower surface** pale brown, slightly shiny, smooth, rarely slightly rugose; margins concolorous to center or slightly darker, shiny, rhizinate, rarely naked, 0.2–1.0 mm wide, smooth; rhizinae concolours with the lower surface, less frequently darkened, simple to irregularly ramified, frequently penicillate, with two distinct sizes, the shorter rhizinae 0.3–1.0 mm long and the longer ones 1.5–2.5 (–4.5) mm long, abundant, evenly distributed. **Apothecia** plane to slightly concave, 2.0–10.0 mm in diameter, adnate, laminal, margins smooth at first, lacerate with age, amphithecia pseudocyphellate, disc dark brown, imperforate; ascospores ellipsoid, 12.5–17.0 × 7.5–10.0 µm, epispore 1.2 µm wide. **Pycnidia** submarginal or laminal, ostiole black; conidia unciform, 4.0–6.0 µm long.

Spot tests: cortex K+ yellow, UV–; white medulla K–, C–, KC–, P– or slightly yellow, UV–; pigmented medulla K+ pale purple or rarely purple. The medulla reacts yellow/orange with the application of commercial 92.8% alcohol.

TLC: traces of atranorin (cortex), caperatic acid, skyrin? (medulla).

Paratypes — Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela, riverside vegetation, 28°02'44.6"S, 51°02'01.7"W, 860 m alt., on a treelet branch in a field on the right margin of Rio Frade, leg. L.S. Canêz & A.A. Spielmann 1247, 11-I-2004 (SP); idem, Municipality of Herveiras, 29°25'51.9"S, 52°40'17.4"W, 570 m alt.,

on shrub base on a roadside steep bank, leg. A. A. Spielmann, L. S. Canêz & C. Trentin 1007, 24-I-2004 (SP).

Comments– This species is recognized by the conspicuous pseudocyphellae, which are visible to the naked eye and restricted to the scrobicular ridges, the pigmented part of the medulla containing a yellow or orange K+ pale purple or purple pigment, and the unciform conidia.

The holotype bears lobulae (wider than long), although the paratypes are lacinulate (longer than wide).

Punctelia bolliana (Müll. Arg.) Krog resembles *P. purpurascens* in having pale lower surface, lobulae in the central part of the thallus and unciform conidia. Although the isotype of *P. bolliana* in BM has lacinulae in the central part of the thallus, the pseudocyphellae on the thallus surface are very scant, and the medulla is entirely white.

The presence of a yellow pigment was more obvious in the distal (marginal) portions of all thalli studied. The presence of ochraceous K+ purple medullary pigment in the genus *Punctelia* was previously reported only for *P. neutralis* (Hale) Krog, an African sorediate species (Krog & Swinscow 1977).

The specific epithet refers to the peculiar K+ purple reaction of the medulla.

Acknowledgements

The authors wish to thank Dr. John A Elix and Dr. Robert Egan for the critical revision of the manuscript, and the lichen curator of BM, Dr. Scott LaGreca, for loan of type specimens.

This work could not have been accomplished without the support of the Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), that provided the master's scholarship of the first author, and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for research support to the second author.

Literature cited

- Bungartz F. 2001. Analysis of lichen substances. IN <http://ces.asu.edu/ASULichens/plb400/laboratory/chemistry/tlc.html>. Accessed in October 2004.
- Canêz LS. 2005. A família *Parmeliaceae* na localidade de Fazenda da Estrela, município de Vacaria, Rio Grande do Sul, Brasil. Mastership dissertation, Instituto de Botânica, São Paulo, 302 pp.
- Egan R, Aptroot A. 2004. *Punctelia*. IN Nash III, TH, Ryan, BD, Diederich P, Gries C, Bungartz F (Eds). Lichen flora of the greater Sonoran Desert Region. Volume 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, USA. p. 431-436.
- Huneck S, Yoshimura I. 1996. Identification of lichen substances. Springer. Berlin. 493 pp.
- Krog H. 1982. *Punctelia*, a new lichen genus in the *Parmeliaceae*. Nordic Journal of Botany 2: 287-292.
- Krog H, Swinscow TDV. 1977. The *Parmelia borreri* group in East Africa. Norwegian Journal of Botany 24: 167-177.

- Marcelli MP. 2004. Checklist of lichens and lichenicolous fungi of Brazil. Version1: June 2004.
http://www.biologie.uni-hamburg.de/checklists/brazil_1.htm.
- Orange A, James PW, White FJ. 2001. Microchemical methods for the identification of lichens.
British Lichen Society. 101 pp.
- Spielmann AA. 2006. Checklist of lichens and lichenicolous fungi of Rio Grande do Sul (Brazil).
Caderno de Pesquisas Série Biologia 18(2). In press.

First record of the genus *Phlebopus* (*Basidiomycotina*, *Boletales*) in Ecuador

GASTÓN GUZMÁN¹*, FLORA CASTILLO-AYOUI²,
ETELVINA GÁNDARA¹ & TRANSVERSin VIVERO²

¹ gaston.guzman@inecol.edu.mx gandara@inecol.edu.mx
Instituto de Ecología

Apartado Postal 63, Xalapa 91000, Veracruz, México

² transvilas@andinanet.ne

Facultad de Ciencias Ambientales, Universidad Técnica Luis Vargas Torres
Casilla Postal: 08-01-0425, Esmeraldas, Ecuador

Abstract—This is the first report of the genus *Phlebopus*, represented by *P. beniensis* and *Phlebopus* sp. from Ecuador. *Phlebopus beniensis* has been previously reported from Argentina, Bolivia, Brazil, Costa Rica and Martinique in the neotropics and from Liberia in Africa.

Keywords—*Gyrodontoidae*, pantropical

Introduction

Phlebopus (R. Heim) Singer is a *Gyrodontoidae* pantropical genus. However, it seems uncommon, based in its scarce bibliographic references (Heim 1936, Heinemann 1953, Singer & Digilio 1960, Heinemann & Rammeloo 1982, Ovrebo 1983, Guzmán & Guzmán-Dávalos 1984, Singer et al. 1990). In 2004, the senior author, in collaboration with several students and colleagues of the Central University of Quito, explored both the tropical Pacific and Atlantic slopes and plains of Ecuador and did not find any species of this genus. However, Castillo-Ayoui made two collections of *Phlebopus* in the NW plains of Ecuador and because they are the first records of this boletaceous genus for the country, they are discussed here.

Materials and methods

Microscopic observations were made from sections of the dry basidiomata, mounted in 5 % KOH solution, Melzer's reagent and cotton blue in lactophenol, after a rehydration with 96 % alcohol.

*Corresponding author

Results

Two species — one identified species and one not identified — are described. The latter is probably a new species but immature and the material is scarce.

Phlebopus beniensis (Singer & Digilio) Heinem. & Rammeloo, Mycotaxon 15: 390, 1982. Figs. 1-5

≡ *Phaeogyroporus beniensis* Singer & Digilio, Lilloa 10: 150, 1960.

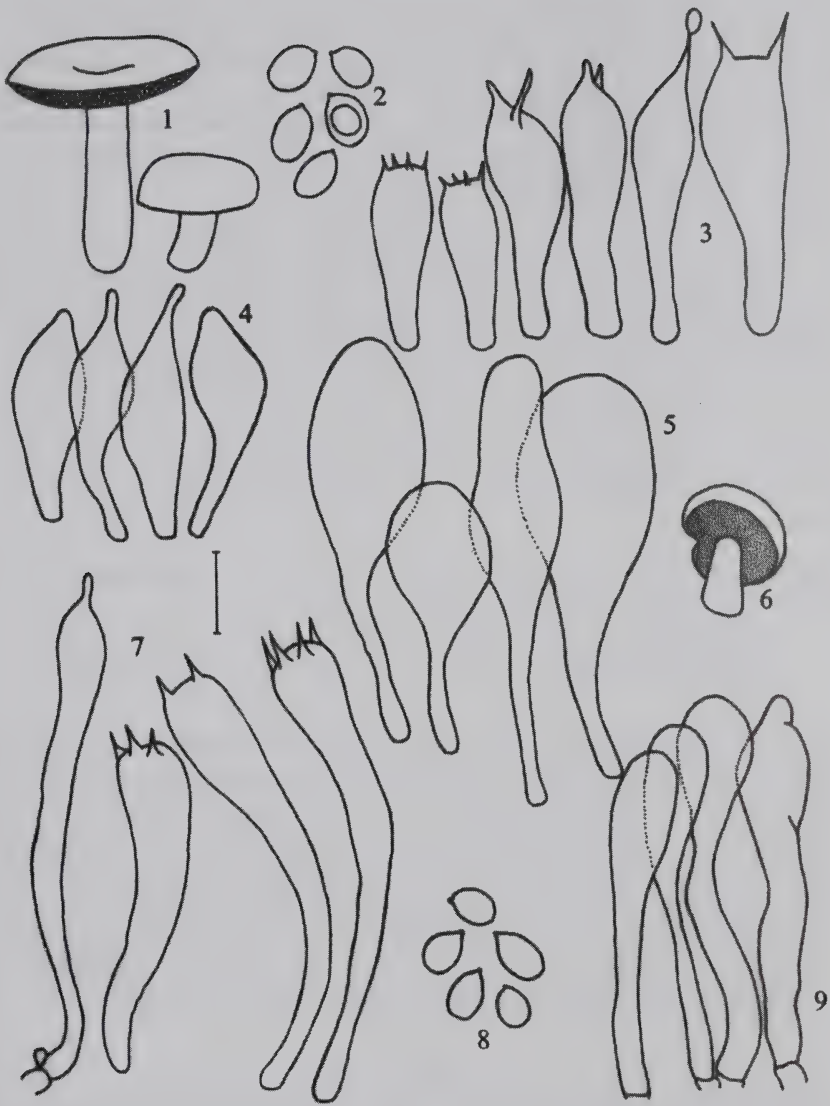
Pileus up to 70 mm diam., subconvex to plane or subconcave, dry, glabrous, yellowish to pale brown. *Hymenophore* tubulose, subadnexed, tubes up to 4 mm long, yellow, becoming bluing to greenish when cut, pores concolorous with tubes, small but visible to the eye, isodiametric, greenish to olive brown, bluing as the tubes when injured. *Stipe* up to 60 x 20 mm, uniform, glabrous, yellowish to brownish-red, mainly toward the base. *Context* yellowish, bluing to greenish when cut as the tubes. *Spore print* yellowish.

Basidiospores (5-) 6-7 x (4-) 4.5-6 µm, subglobose or subellipsoid, thin-walled, yellowish, with a subglobose refracting guttula. *Basidia* 20-35 (-47) x 8-10 (-12) µm, 1-, 2- or 4- spored, clavate sterigmata short or long and up to 10 µm long, clavate, yellowish. *Pleurocystidia* (22-) 23-29 (-32) x (6-) 6.5-9 µm, rare, ventricose-rostrate, with a narrow base and short or long subcylindrical apex, pale yellowish. *Cheilocystidia* (24-) 30-54 (-65) x (10-) 11-15 (-16) µm, shaeropedunculate or vesiculososo-pedunculate, thin-walled, pale yellowish. *Hymenophoral trama* subregular, with hyphae 3-8 µm wide, yellowish. *Pileus trama* little differentiated, with hyphae 5-12 µm wide, thin-walled, yellowish. *Pileipellis* as a trichodermium, yellowish, with some dermatocystidia-like hyphae, up to 8 µm wide. *Clamp connections* common.

Habitat and distribution—On soil, probably ectomycorrhizal with dicotyledonous trees, in a tropical forest used to culture fruit trees, at sea level. This species is known from Argentina, Bolivia, Brazil, Costa Rica and Martinique in America and Liberia in Africa, according to Heinemann & Rammeloo (1982), Singer & Digilio (1960) and Singer et al. (1990).

Specimen examined. ECUADOR, Cantón Quinindé, route Quinindé to Santo Domingo, km 200, March 1 2006, Castillo-Ayoui s.n. "A" (Herb. Univ. Tec. L. Vargas Torres at Esmeraldas; XAL).

The material agrees with the descriptions of Heinemann & Rammeloo (1982); they reported basidiospores 5.6-6.8 x 4.3-5.2 µm or 4.9-6.8 x 3.8-5.9 µm; also it agrees with Singer & Digilio (1960) who reported spores 6-7 x 4.2-5.5 µm, basidia 22 x 7.5 µm and cystidia 22-41 x 7-8.5 µm, and with Singer et al. (1990) who reported spores 6-7.5 x (3.5-) 4.5-6.2 µm, basidia 12-29 x (6-) 7-8 (-9) µm, 4- spored, and cystidia 14-44 x 3.5-14.5 µm.



Figs. 1-9. 1-5. *Phlebopus beniensis*. 1: basidiomata, 2: basidiospores, 3: basidia, 4: pleurocystidia, 5: cheilocystidia.

6-9: *Phlebopus* sp., 6: basidioma, 7: basidia, 8: basidiospores, 9: cheilocystidia.

Scale bar: 30 mm in 1, 38 mm in 6 and 10 μ m in the others.

Phlebopus sp.

Figs. 6-9

Pileus up to 60 mm diam., convex to plane-convex, dry, glabrescent, brownish-orange to brownish-grey. *Hymenophore* tubulose, adnexed, tubes yellowish pink, up to 5 mm long, pores very small, difficult to see, orangish pink. *Stipe* up to 50 x 15 mm, subbulbous, concolorous with pileus, but with the base whitish, solid, smooth. *Context* whitish, but yellowish below the surface and reddish toward the stipe base. *Spore print* unknown.

Basidiospores (4-) 4.5-5 (-6) x 4-4.5 (-5) μm , globose, subglobose, subellipsoide or ellipsoid, thin-walled, yellowish. *Basidia* 35-55 x 6-9 μm , 1- (rare), 2-, 3-, 4-spored, short or long sterigmata, up to 10 μm long, hyaline, yellowish or yellow. *Pleurocystidia* not seen. *Cheilocystidia* (31-) 35-45 x 6-8 μm , clavate-subcylindrical, some with a narrow subglobose apex, hyaline or yellowish. *Hymenophoral trama* subregular, with hyphae 3.5-7 μm wide, thin-walled, yellowish. *Pileus trama* with repent hyphae 4-15 μm wide, thin-walled, yellowish. *Pileipellis* as a trichodermium, with hyphae 4-7 μm wide, thin-walled, hyaline or yellowish. *Oleiferous hyphae* 3-7 (-11) μm wide, yellow. *Clamp connections* common.

Habitat: On soil, probably ectomycorrhizal with some dicotyledonous trees, tropical forest with cultured fruit trees, sea level.

Specimen examined. ECUADOR, Cantón Quinindé, route Quinindé to Santo Domingo, km 200, January 10, 2006, *Castillo-Ayoui s.n.* "B" (Herb. Univ. Téc. L. Vargas Torres at Esmeraldas; XAL).

The material does not agree with any of the species considered by Heinemann & Rammeloo (1982) and Singer et al. (1990). The only species of the 12 considered by Heinemann & Rammeloo (1982) with a pileipellis as a trichodermium is *P. beniensis*, which presents large spores. Singer et al. (1990) only considered *P. beniensis* and *P. portentosus* (Berk. & Broome) Boedijn with trichodermium, the latter known from Mexico and Costa Rica, with an ixotrichodermium, but with spores 5.5-9.5 x 4.8-6.8 μm . It is probably that the Ecuadorian *Phlebopus* here discussed is a new species, but the poor quality of the herbarium material along with its immature condition make it difficult to present a good description.

Acknowledgments

The senior author and E. Gándara thank Virginia Ramírez-Cruz for her help in the laboratory, also to Juan Lara Carmona in the herbarium and Manuel Hernández in computer services. The senior author also expresses his acknowledgment to Carlos E. Cerón from the Escuela de Biología at the Universidad Central de Ecuador in Quito, for his help in the field trips made in Ecuador. Castillo-Ayoui and Vivero thank the Universidad Técnica de Esmeraldas, Ecuador. This paper was reviewed by the colleagues Arthur L. Welden of Tulane University, Florencia Ramírez-Guillén of Instituto de

Ecología at Xalapa, Laura Guzmán-Dávalos from Universidad de Guadalajara and Clark L. Ovrebo of University of Central Oklahoma to whom the authors are grateful.

Literature cited

- Guzmán G, Guzmán-Dávalos L. 1984. Nuevos registros de hongos en el estado de Veracruz. Bol. Soc. Mex. Mic. 19: 221-244.
- Heim R. 1936. Observations sur la flore mycologique Malgache III. Rev. Mycol. 1: 4-18.
- Heinemann P. 1953. *Boletinae*. IN: Beeli M, Goossens-Fontana M. Flore Iconographique des Champignons du Congo. Lebègue Eds., Brussels.
- Heinemann P, Rammeloo J. 1982. Observations sur le genre *Phlebopus*. Mycotaxon 14: 384-404.
- Ovrebo CL. 1983. New records of fleshy fungi from Venezuela. Mycotaxon 18: 355-356.
- Singer R, Digilio APL. 1960. Las Boletáceas de Sudamérica tropical. Lilloa 30: 141-164 + pls. I-II.
- Singer R, García J, Gómez LD. 1990. The *Boletinae* of Mexico and Central America I & II. Beih. Nova Hedwigia 98, Berlin.

A new bluing species of *Psilocybe*, section *Stuntzii*, from New Mexico, U.S.A.

GASTÓN GUZMÁN^{1*}, LEE WALSTAD²,
ETELVINA GÁNDARA¹ & FLORENCIA RAMÍREZ-GUILLÉN¹

¹*gaston.guzman@inecol.edu.mx*

Instituto de Ecología

Apartado Postal 63, Xalapa 91000, Mexico

²*bossk@nmt.edu*

Institute Technology

P.O. Box 2575, Socorro, New Mexico 87801, U.S.A.

Abstract—*Psilocybe mescaleroensis* is described as a new species from Sierra Mescalero, in New Mexico, U.S.A. It is a bluing mushroom, belonging to section *Stuntzii*, where all the species seem to have hallucinogenic properties. This is the first record of a caerulescent *Psilocybe* from New Mexico.

Keywords— *Basidiomycotina*, *Agaricales*, *Strophariaceae*

Introduction

The monograph of The Genus *Psilocybe* (Guzmán 1983), along with its supplement (Guzmán 1995), are both out of print, but since these publications, the senior author continued to study the genus (e.g. Guzmán 2004, 2005; Guzmán & Trappe 2005, Gándara & Guzmán 2006) and he is currently amassing information for the second edition of the monograph. During the review of a material collected by Walstad and colleagues in New Mexico, U.S.A., the authors found a new bluing species that is described herein.

Materials and methods

Microscopic observations were made through sections of the basidiomata, mounted in 5% KOH, 10% NH₄OH and Congo red, previously treated with 96% alcohol for rehydration. Spore dimensions indicate length, width, and thickness. The colors of the basidiomata are based upon Wanscher and Kornerup (1991).

* Corresponding author



Figs. 1-10. *Psilocybe mescaleroensis* (from holotype). 1-7: Basidiomata (observe the development of the ephemeral annulus in 1 & 2 from an adherent membrane in 6 and its absence in 3-5 & 7. Also observe the subradicating and strigose stipe base in 5, the lobulate pileus in 7 and the hygrophanous pileus in 1 & 4). 8: Basidiospores; 9: Basidia, 10: Cheilocystidia (those branched are rare).

Scale bar 20 mm in 1-7; 10 μ m in 8-10.

Psilocybe mescaleroensis Guzmán, Walstad, E. Gándara & Ram.-Guill., sp. nov.

MYCOBANK MB 510461

Figs. 1-10

Etymology. From Mescalero which is the name of both Indians and mountains where the species was found.

Pileus (20-) 30-45 (-60) mm *latus*, *convexus vel subumbonatus*, *frequens undulatus*, *brunneolus flavidus vel suboscurus*, *frequens apex subaurantiacus*, *hygrophanous*, *pellicula gelatinous disjungere*. *Lamellae* *adnatae vel annexa*, *subalbida vel brunneolus vel roseo-brunneolus*, *vel cacainus*, *marginis concolor*. *Annulus breviter membranaceus*, *caducus*. *Stipes* (50-) 60-70 (-100) x 5-8 (-20) mm, *albidus vel inaequalitas subaurantiacus*, *basis subrhizomorpha*, *strigosa*. *Sporae* (9-) 10-11 (-13) x 6-7 (-8) x 6-7 μ m, *subrhomboides vel subovoid*, *pariete 0.8-1 μ m crassis*, *brunneolus*, *poro germinali lato*. *Pleurocystidia absentia*. *Cheilocystidia* (16-) 19-27 (-30) x 5-8 μ m, *hyaline*, *fusiformis*, *interdum sublageniform*. *Subhymenium subcellularis*. *Pileipellis instar ixocutis*. *Fibulae communis*. *United States*, *New Mexico*, *Mezcalero Mons*, *Lincoln prope*, *ad Mezcalero oppidum*, *Julius 2004*, *Walstad*, *holotype (XAL)*.

Pileus (20-) 30-45 (-60) mm diam, convex to subumbonate, margin frequently wavy, pale brownish-yellow (4A3-4) to darker (4B5-7), frequently with the disc more orange (4A7-8), hygrophanous, changing to pale brownish (close to 9E2), translucent striate when wet, pellicle gelatinous, separable. *Lamellae* adnate to adnexed, dirty whitish (4A2) to pale brownish-gray (4B4-5) or brownish-rose (6A3), finally dark chocolate (7E4-5), edges concolorous. *Annulus* close joined to the surface of the stipe, slightly membranaceous, white or getting the color of the spore print on the upper surface, ephemeral. *Context* whitish to pale grayish (4A2-3), with slight farinaceous odor and taste. *Stipe* (50-) 60-70 (-100) x 5-8 (-20) mm, cylindrical, equal or thicker toward the apex, flexuous, fibrillose, solid to hollow, whitish to irregularly orange (5A7) or orangish-pink (close to 7A3-4), base somewhat rhizomorphic, frequently strigose. All the basidioma bluing, except lamellae. *Spore print* dark chocolate (7E-4).

Basidiospores (9-) 10-11 (-13) x 6-7 (-8) x 6-7 μ m, subrhomboid or subovoid in face-view, subovoid in side-view, thick-walled, wall up to 1 μ m thick, yellowish-brown, with a distinct and broad germ pore at distal pole and a short asymmetric appendage in the other. *Basidia* 35-39 x 7.5-9 μ m, 4-spored, subclaviform, hyaline. *Pleurocystidia* absent. *Cheilocystidia* (16-) 19-27 (-30) x 5-8 μ m, hyaline, fusiform, ventricose-rostrate, regular or irregularly in shape, rarely irregularly branched. *Hymenophoral trama* regular, hyphae 4-5 μ m wide, thin-walled, hyaline to yellowish. *Pileipellis* an ixocutis up to 155 μ m thick, hyphae 2-5 μ m wide, thin-walled, hyaline. *Subhymenium* subcellular, hyaline to yellowish. *Clamp connections* present.

Habitat and distribution—Rarely solitary, frequently scattered to gregarious, also caespitose on rich soil or decaying grasses, in grasslands near to a *Pinus ponderosa* Douglas ex C. Lawson forest, commonly associated with the holes of gophers. Observed in summer and autumn. Known only from the type locality.

Studied Material. UNITED STATES, New Mexico: Mescalero Range, Sierra Blanca, Lincoln Co., near town Mescalero, July 2004, Walstad s.n. (holotype XAL, isotype NY).

Discussion– This new species belongs to section *Stuntzii* Guzmán (Guzmán 1983), because of the subrhomboid, thick-walled basidiospores, presence of an annulus, and the bluing feature. It differs from *P. stuntzii* Guzmán & J. Ott (Guzmán 1983, Guzmán & Ott 1976) for its more robust basidiomata with subradicating and strigose stipe bases and cheilocystidia lacking elongate and flexuous necks. *Psilocybe stuntzii* has a (5-) 10-20 (-35) mm diam pileus and lageniform cheilocystidia with long necks (Guzmán & Ott 1976, figs. 7 and 8). Also, *P. stuntzii* is known only from the Pacific regions of Canada and the U.S.A. Although information gathered by Walstad and friends is somewhat confusing, it is probable that *P. mescaleroensis* had or still has a sacred use among the Indians.

Acknowledgments

We appreciate the help of Dr. Clark Ovrebo (University of Central Oklahoma, USA), and Laura Guzmán-Dávalos (Universidad de Guadalajara, Mexico) for critically reviewing this paper. Walstad thanks his colleagues Daniel Cornelius and Brian Painter for their help in the field trips. The senior author is indebted to the authorities of CONACYT, SNI and Instituto de Ecología at Xalapa for supporting his researches, and also thanks to Juan Lara Carmona and Manuel Hernández from the same institute for their help.

Literature cited

- Gándara E, Guzmán G. 2006. The status of *Psilocybe floridana* (Strophariaceae) in *Callistosporium* (Tricholomataceae). Mycotaxon 96: 73-76.
- Guzmán G. 1983. The genus *Psilocybe*. Beih. Nova Hedwigia 74, J. Cramer, Vaduz.
- Guzmán G. 1995. Supplement to the monograph of the genus *Psilocybe*. In: Taxonomic monographs of Agaricales, Petrini O, Horak E (eds.). Bibliotheca Mycologica 159, J. Cramer, Berlin.
- Guzmán G. 2004. Revision of the classification of the genus *Psilocybe* I. Section *Neocaledonicae*, a new section in *Psilocybe*. Revista Mexicana de Micología 18: 27-29.
- Guzmán G. 2005. Species diversity of the genus *Psilocybe* in the world mycobiota, with special attention to hallucinogenic properties. International Journal of Medicinal Mushrooms 7: 305-331.
- Guzmán G, Ott J. 1976. Description and chemical analysis of a new species of hallucinogenic *Psilocybe* from the Pacific Northwest. Mycologia 68: 1261-1267.
- Guzmán G, Trappe JM. 2005. The hallucinogenic species of the genus *Psilocybe* in Washington State, USA: new records and a new species. International Journal of Medicinal Mushrooms 7: 583-589.
- Wanscher JH, Kornerup A. 1991. Farver I Farver. Politekens Forlag, Kobenhavn.

***Anthracoidea setschwanensis* sp. nov. (Ustilaginales)
and a new record of *Anthracoidea* from China**

LIN GUO

guol@sun.im.ac.cn

Key Laboratory of Systematic Mycology and Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

Abstract—A new species, *Anthracoidea setschwanensis* on *Kobresia setschwanensis*, is described, which was collected in Gongga Mountain of Sichuan Province, China. *Anthracoidea irregularis* on *Carex lanceolata* and *C. quadriflora* is new to China, which was collected from Inner Mongolia Autonomous Region and Hebei Province.

Key words—*Ustilaginomycetes*, smut fungi, taxonomy

A new species of *Anthracoidea* on *Kobresia setschwanensis* was discovered in the Herbarium of the Institute of Botany, Chinese Academy of Sciences (PE) on *Kobresia setschwanensis*. The specimen was collected in Gongga Mountain of Sichuan Province at 4500 m altitude in 1981. The host plant, in the section *Elyna* of the genus *Kobresia*, is an endemic Chinese species distributed in eastern Xizang Autonomous Region, southeastern Qinghai Province, western and northern Sichuan Province and northwestern Yunnan Province (Dai & Liang 2000). The new species is quite different from *Anthracoidea xizangensis* L. Guo (Guo 2006a), *A. bistaminatae* L. Guo (Guo 2006b) and *A. mulenkoi* M. Piątek (Piątek 2006) in section *Elyna* by having larger ustilospores (see below). The new species is described as:

***Anthracoidea setschwanensis* L. Guo, sp. nov.**

Figs. 1-2

MYCOBANK MB510470

Sori in ovariiis, ovoidei, 1.8–2.2 mm longi, 1.5–2 mm lati, primum membrana cinerascenti fungali cooperti, deinde expositi. Massa sporarum nigra, semiagglutinata. Ustilosporae a fronte subglobosae, ellipsoideae, ovoideae vel leviter irregulares, 18.5–27.5(–30) × 16–25.5 µm, ab acie 12–16 µm latae, flavidobrunneae vel rubrobrunneae; pariete aequaliter incrassato, 1–2.5(–3.5) µm crasso, interdum hyalinae calyptrae, tumores interni desunt, regiones lucem repercutientes desunt, superficie minute et dense verruculoso, verrucis interdum confluentibus sub SEM.

Sori in ovaries, ovoid, 1.8–2.2 mm long, 1.5–2 mm wide, at first covered by a grayish fungal membrane, later becoming exposed. Spore mass black, semi-agglutinated. Ustilospores in plane view subglobose, ellipsoidal, ovoid or

slightly irregular, 18.5–27.5(–30) x 16–25.5 µm, in side view 12–16 µm wide, yellowish-brown or reddish-brown; wall evenly thickened, 1–2.5(–3.5) µm, occasionally with hyaline caps on the flat sides, no internal swellings, no light reflective areas, surface minutely and densely verruculose, sometimes the warts confluent as seen by SEM.

On *Kobresia setschwanensis* Hand.-Mazz. (Cyperaceae, Sect. *Elyna*), China: Sichuan, Daocheng, Gongga Mt., alt. 4500 m, 30 VIII 1981, Qinghai-Tibet expedition 5831, HMAS 143945 (holotype), HUV 21414 (isotype)

Key to the *Anthracoidea* species on section *Elyna* of genus *Kobresia*

1. Ustilosporos smooth, 17–22(–25) x (14–)15–18.5 µm, walls 1–2.5(–3) µm thick
..... *A. elyinae*
1. Ustilosporos verruculose 2
2. Ustilosporos large, 18.5–27.5(–30) x 16–25.5 µm. *A. setschwanensis*
2. Ustilosporos smaller 3
3. Ustilosporos 15–20 x 12.5–18 µm, surface punctate on the flat sides, profile
verruculose as seen by SEM, walls 1–1.5(–2) µm thick *A. bistaminatae*
3. Ustilosporos verruculose on whole surface 4
4. Ustilosporos densely verruculose, 17–22.5 x 15–18 µm, walls 1.5–2 µm thick
..... *A. xizangensis*
4. Ustilosporos sparsely verruculose, 18–23(–25) x 16–20(–22) µm, walls 1–3 µm thick
..... *A. mulenkoi*

Anthracoidea irregularis (Liro) Boidol & Poelt, Ber. Bayer. Bot. Ges. 36: 23, 1963.

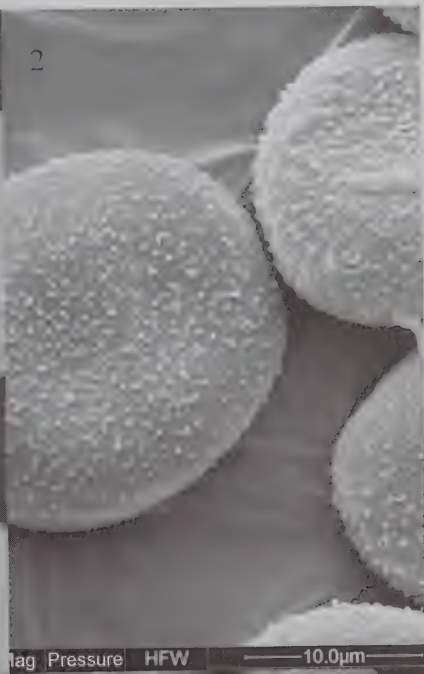
Figs. 3–4

Sori in ovaries, subglobose, 2–3 mm in diam., at first covered by a grayish, fungal membrane, later becoming exposed. Spore mass black, semi-agglutinated. Ustilosporos in plane view irregular, polygonal, subglobose, ellipsoidal or ovoid, (13–)16–30(–37) x (12.5–)16–23 µm, in side view 9–15 µm wide, dark reddish-brown; wall unevenly thickened, 1–2.5(–3.5) µm, with numerous protuberances, 1–3 internal swellings, and light reflective areas, surface verruculose.

On *Carex lanceolata* Boott (Cyperaceae, Sect. *Digitatae*), China: Inner Mongolia, Xilinhot, Huitengcaoyuan, alt. 1380 m, 18 VII 2003, L. Guo, W. Li & H.C. Zhang 2096, HMAS 164225.

On *Carex quadriflora* (Kük.) Ohwi (Cyperaceae, Sect. *Digitatae*), China: Hebei, Wulingshan, alt. 1000 m, 17 V 2004, L. Guo & H.C. Zhang 2541, HMAS 165043.

Figs. 1–2. *Anthracoidea setschwanensis* on *Kobresia setschwanensis* as seen by LM and SEM (HMAS 143945, holotype). Figs. 3–4. *Anthracoidea irregularis* on *Carex quadriflora* as seen by LM and SEM (HMAS 165043).



So far, four species of *Anthracoidea* on the section *Elyna* of *Kobresia* and five species of *Anthracoidea* on the section *Digitatae* of *Carex* have been reported from China (Guo 2000, 2004, 2006ab; Zhang & Guo 2004).

Acknowledgements

The author would like to express her deep thanks to Drs. Vánky and Piątek for reading the manuscript and serving as pre-submission reviewers, to Dr. Pennycook for nomenclatural review, to the Director of the Herbarium, Institute of Botany, Chinese Academy of Sciences (PE) for permission to seek the smut fungus in the Herbarium of PE and to Mrs. Xie Jiayi for assistance with SEM photographs. This study was supported by the Ministry of Science and Technology of the People's Republic of China (No. 2005DKA21401).

Literature cited

- Dai LK, Liang SJ. 2000. Flora Reipublicae Popularis Sinicae, Tomus 12, *Angiospermae, Monocotyledoneae, Cyperaceae* (2) *Caricoideae*. Science Press, Beijing, 1-582.
- Guo L. 2000. Flora Fungorum Sinicorum, *Ustilaginaceae* Vol. 12, Science Press, Beijing, 124 pp.
- Guo L. 2004. *Anthracoidea shaanxiensis* sp. nov. (*Ustilaginales*) from China. *Nova Hedw.* 79: 507-509.
- Guo L. 2006a ('2005'). Two new species of *Anthracoidea* (*Ustilaginales*) from China. *Mycotaxon* 94: 47-50.
- Guo L. 2006b. Six new species of *Anthracoidea* (*Ustilaginales*) from China. *Fungal Diversity* 21: 81-92.
- Piątek M. 2006. *Anthracoidea mulenkoi* (*Ustilaginomycetes*), a new cypericolous smut fungus from Pakistan. *Nova Hedw.* 83: 109-116.
- Zhang HC, Guo L. 2004. Two new species and a new record of *Anthracoidea* (*Ustilaginales*) from China. *Mycotaxon* 89:307-310.

***Antrodiella semistipitata* (Basidiomycetes, Polyporales), a new species from Italy**

ANNAROSA BERNICCHIA¹, LEIF RYVARDEN²
& TATIANA BAPTISTA GIBERTONI¹

abernicc@agrsci.unibo.it leif.ryvarden@bio.uio.no tbgibertoni@hotmail.com

¹*Dipartimento di Scienze e Tecnologie Agroambientali
Università degli Studi di Bologna, Via Fanin 42, Bologna, I-40127, Italy*

²*Botany Department, University of Oslo
Box 1045, Oslo, N-0316, Norway*

Abstract — *Antrodiella semistipitata* is described as a new species and its main differentiating characters are outlined. Figures, descriptions and a key to European *Antrodiella* species are provided.

Key words — polypores, taxonomy

Introduction

The genus *Antrodiella* Ryvarden & I. Johans. was described in 1980 (Ryvarden & Johansen 1980) to include seven polypores with basidiomata almost wax-like when fresh, becoming dense, hard and semitranslucent when dry, and generally with small pores and basidiospores (usually less than 5 µm). Later, many species were described or transferred to the genus (Niemelä 1982; Ryvarden 1984, 1987, 1990, 1992; Ryvarden & Gilbertson 1984, 1993; David & Tortić 1986; David & Lecot 1990; Gilbertson & Ryvarden 1986; Buchanan & Ryvarden 1988, 1993; Vampola 1991; Hattori & Ryvarden 1993, 1994). Vampola & Pouzar (1996) emended the genus, accepted 35 species, and described four new species, two of which are now considered synonyms of *Antrodiella pallescens* (Pilát) Niemelä & Miettinen.

Recently, Johannesson et al. (2000) reported on ca. ten European species forming a monophyletic group, Piątek (2001) provided a survey of the genus in Poland, and Miettinen et al. (2006) treated the Northern *Antrodiella* species in connection with studies in the *A. semisupina*-complex, additionally introducing some name changes that are incorporated in the key given below. Currently approximately 40 species of *Antrodiella* are accepted (CBS 2006). Of the 10–15

registered in Europe (Ryvarden & Gilbertson 1993, CBS 2006), nine occur in Italy (Bernicchia 2005).

European *Antrodiella* species are usually resupinate or pileate-sessile, occasionally flabelliform, fan- or fingernail-shaped (as in *A. pallasii*, *A. faginea* and *A. pallescens*), or rarely with a contracted base (as in *A. canadensis*). Some substipitate specimens collected in 1991 near Val di Genova (Trento, North Italy) and neglected for almost 15 years have now been rediscovered and are here described as a new species.

Taxonomic Description

Antrodiella semistipitata Bernicchia & Ryvarden sp. nov.

MYCOBANK #MB510492

Basidiomata annua, cremea, semistipitata, semicirculata, sed iuxtim coalita, fragilia post siccationem, usque ad 20mm lata, ad 25mm alta, guepinioidea forma. Pori rotundati, 4-7 per mm, cremei, margine glabro, inclinato deorsum subtile. Subiculum cremeum, subtilissimum, tubuli 0.5mm crassi. Hypharum structura dimitica: hyphae hyalinae, haud amyloideae, haud dextrinoideae; hyphae generativae parietibus subtilibus, ramosae, fibulatae, 1.5-2.5 µm diametro. Hyphae skeletales sinuosae, intextae, parietibus crassioribus, 1.5-4 µm diametro, in tubulorum stratu rara crystallata. Cystidia absunt, cum cystidiola adsint, 20-25 µm longa et 4.2-5 µm lata. Basidia hyalina, clavae forma, tetrasterigmatica, fibulata, 8-9 µm longa et 4.5-5 µm lata, sterigmata 3 µm longa. Basidiosporae hyalinae, laeves, subtilibus parietibus, cylindratae, subcylindratae, haud amyloideae, haud dextrinoideae, acyanophilae, (2.8-) 3-4 (-4.2) µm longae et 1.8-2 (-2.3) µm latae.

Holotypus: Italy, Trento, (North Italy) Val di Genova, on small branch of *Corylus avellana*, alt 1100m 3.IX.1991, leg. A. Bernicchia et A. Contestabile, HUBO 7824 (isotype in O).

Etymology: The name points out the particular shape of basidiomata.

Basidiomata annual, semistipitate, fan-shaped, single but pilei closely attached to each other in a group of four basidiomata, whitish when fresh, cream and fragile when dried; 20 mm long, 25 mm wide, 0.6 mm thick, with a contracted base that provides the semistipitate aspect. Margin entire, refolded towards the bottom to form a cercine. Pore surface whitish to cream, pores small, regular, round, 4-7 per mm, decurrent to the pseudostipe. Margin smooth, entire, sharp and bent down. Subiculum very thin, cream; tubes concolorous, 0.5 mm deep.

Hyphal system dimitic, hyphae hyaline, IKI-; generative hyphae few, branched, clamped, thin-walled, 1.5-2.5 µm in diam.; skeletal hyphae predominant, straight to slightly sinuous, thick-walled, interwoven, 1.5-4 µm in diam, crystalline clumps rare. **Cystidia** absent, cystidioles clavate, sinuous, 18-20 x 4.2-5 µm. **Basidia** hyaline, clavate, with basal clamp, 8-10 x 4.5-5 µm, 4 sterigmata, 3 µm long. **Basidiospores** hyaline, smooth, thin-walled, cylindrical to sub-cylindrical, IKI-, acyanophilous, (2.8-) 3-4 (-4.2) x 1.8-2 (-2.3) µm (Fig. 2).



Figure 1. Basidiomata of *Antrodiella semistipitata*.
A: hymenophore surface, B: sterile upper surface

Substrata — Known only from deciduous wood.

Distribution — Known only from the type locality.

Comments — Although the material available is scarce, the remarkable shape of the basidiomata and the microscopical characteristics, seem clearly to indicate that the collection represents a new species. Among the European pileate species of the genus, *A. canadensis*, *A. pallescens*, *A. pallasii* and *A. faginea* may have a contracted base, but the former has ellipsoid to ovoid basidiospores, and is found only on *Picea* and *Pinus*, while *A. faginea* has ellipsoid basidiospores and grows on a number of deciduous trees; *A. pallescens* has short-cylindrical or ellipsoid basidiospores and grows both on coniferous and deciduous trees, while in *A. pallasii* they are ellipsoid, and the species is found on coniferous trees.

Key to the European species of *Antrodiella*

- 1a. Basidiomata mainly on coniferous trees 2
- 1b. Basidiomata on deciduous trees 5
- 2a. Basidiomata distinctly pileate, upper surface grey to brown with radial lines, basidiospores subglobose to drop-shaped, $3.1-3.9 \times 2.4-3.0 \mu\text{m}$... *A. canadensis*
- 2b. Basidiomata resupinate to fan-shaped, basidiospores differently shaped 3

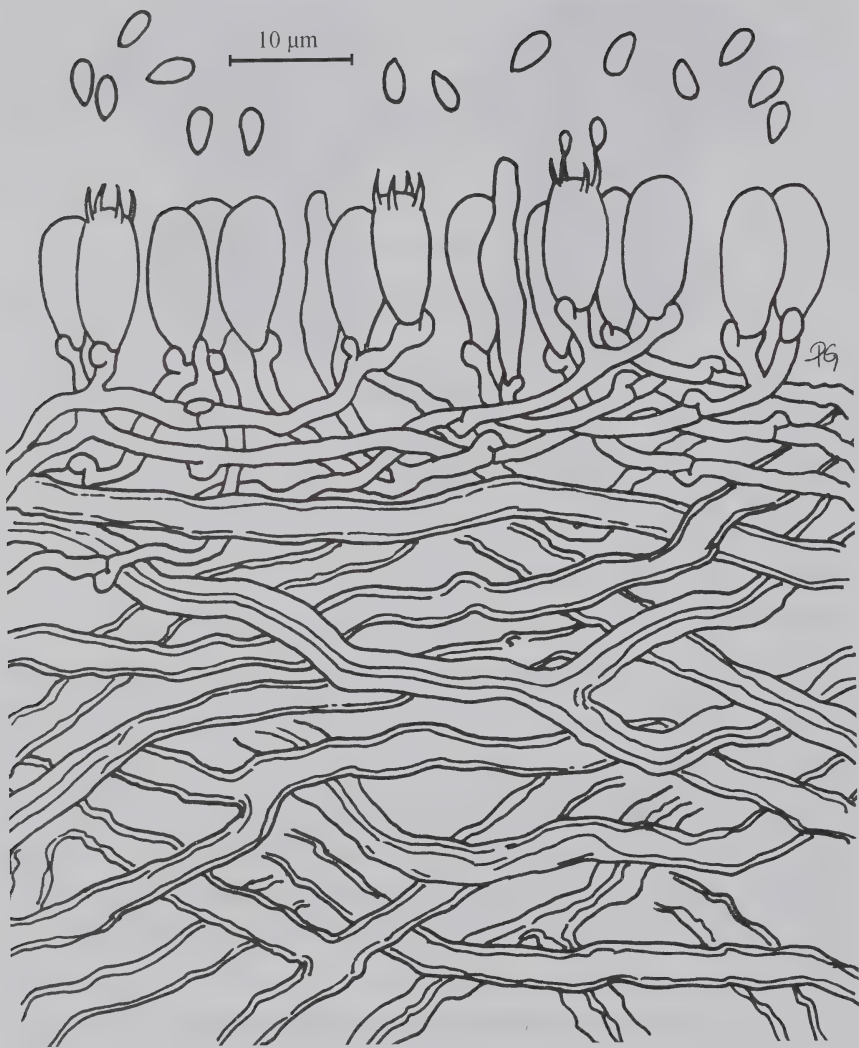


Figure 2. Hymenial elements of *Antrodiella semistipitata*

- 3a. Basidiomata often fan-shaped, basidiospores ellipsoid, 3-3.7 x 1.8-2.1 μm, boreal Fennoscandian species, strictly follower of *Trichaptum* spp. *A. pallasii*
- 3b. Basidiomata resupinate, cystidia present or absent 4

- 4a. Pore surface citric yellow, growing on wood previously rotted by *Fomitopsis pinicola*, cystidia absent, basidiospores subglobose, 2.9-3.4 x 2.1-2.6 µm; also collected also *Betula* and *Alnus*, apparently restricted to boreal coniferous forest. *A. citrinella*
- 4b. Pore surface white to cream, growing on or close to *Trichaptum abietinum*, smooth cystidia present, basidiospores mainly ellipsoid, 3.3-4.0 x 2.2-2.9 µm, Central European species *A. parasitica*
- 5a. Basidiomata pileate 6
- 5b. Basidiomata resupinate 14
- 6a. Basidiomata semistipitate, fan-shaped or with a contracted base, margin refolded forming a cercine, basidiospores cylindrical to subcylindrical, 3-4 x 1.8-2.0 µm, on *Corylus*. *A. semistipitata*
- 6b. Basidiomata pileate, effused-reflexed, fingernail shaped or sessile, with different margin 7
- 7a. Sterile surface yellow, fading when dry, finely hirsute to distinctly warted, usually growing on or close to *Inonotus radiatus*. *A. serpula* (syn. *A. hoehnelii*)
- 7b Sterile surface differently coloured, glabrous to finely velutinate, smooth to slightly zonate 8
- 8a. Hymenophore lacerate to almost hydroid *A. foliaceodentata*
- 8b. Hymenophore poroid. 9
- 9a. Pileus cinnamon to pale orange, with strong scent of coumarin when fresh, basidiospores ovoid, 3-4 x 2-3 µm *A. fragrans*
- 9b. Pileus whitish to ochraceous, no particular scent when fresh, basidiospores ellipsoid, cylindrical to allantoid 10
- 10a. Basidiomata pileate, effused-reflexed, fingernail-shaped to flabelliform, rarely resupinate, basidiospores ellipsoid 11
- 10b. Basidiomata pileate, effused-reflexed, basidiospores cylindrical 13
- 11a. Basidiomata pileate, sterile surface, when present, apricot to orange when fresh, drying pale brown; basidiospores 1.5-2.2 µm wide; smooth cystidia. occasionally present *A. fissiliformis*
- 11b. Basidiomata effused-reflexed, fingernail-shaped to flabelliform, sterile surface different, gloecystidia present or mostly absent 12
- 12a. Gloecystidia mostly absent, basidiospores short cylindrical to ellipsoid, 3.0-4.1 x 1.7-2.0 µm, growing on or close to *Fomes fomentarius* *A. pallascens*
- 12b. Gloecystidia present, basidiospores ellipsoid, 2.8-3.7 x 1.8-2.2 µm, successor species of some *Hymenochaetaceae* *A. faginea*
- 13a. Generative hyphae with simple septa, basidiospores 3.2-4.5 x 1.5-1.9 µm *A. onychoides*
- 13b. Generative hyphae with clamps, basidiospores 1-1.5 µm wide *A. leucoxantha* (syn. *A. genistae*)

- 14a. Pores angular, 2-3 per mm, with lacerate orifices, basidiospores 3.2-4.4 x 1.9-2.3 μm , usually on or close to *Hymenochaete* spp. *A. americana*
- 14b. Pores round, 3-8 per mm, with no lacerate orifices, on dead wood or old polypores 15
- 15a. Basidiomata growing on dead polypores of *Hymenochaetaceae*, gloeocystidia present, basidiospores 1.8-2.2 μm wide *A. faginea*
- 15b. Basidiomata growing on dead wood, cystidia present or absent 16
- 16a. Basidiospores straight, cylindrical, 4.3-5.2 x 1.9-2.2, cystidia absent
..... *A. ichnusana*
- 16b. Basidiospores shorter, ellipsoid, cystidia present or absent 17
- 17a. Pore surface cream to pale straw-coloured, cystidia absent, basidiospores 3.4-4.4 x 2.3-2.9 μm *A. romellii*
- 17b. Pore surface cream to pale yellowish brown, cystidia occasionally present, basidiospores 3.0-4.0 x 1.5-2.2 μm *A. fissiliformis*

Acknowledgements

Dr. Tuomo Niemelä, University of Helsinki and Petr Vampola of Czech Republic, have read the manuscript and suggested useful improvements for which we express our gratitude. We thank also MSc. Sergio Pérez Gorjón for providing the figures.

Literature cited

- Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europei, 10. Ed. Candusso: Alassio (Italy).
- Buchanan PK, Ryvarden L. 1988. Type studies in the *Polyporaceae* 18. Species described by G.H. Cunningham. Mycotaxon 31: 1-38.
- Buchanan PK, Ryvarden L. 1993. Type Studies in the *Polyporaceae* 24. Species described by Cleland, Rodway and Cheel. Australian Systematic Botany 6: 215-235.
- CBS. 20/11/2006. www.cbs.knaw.nl/databases/index.htm.
- David A, Torti  M. 1986. Contribution a l tude de quatre polypores europ ennes peu connus. Cryptogamie, Mycologie 7: 1-13.
- David A, Lecot C. 1990. Pour une lecture actualis e des Hym nomyc tes de France de Bourdot et Galzin. Bulletin Trimestriel de la Soci t  Mycologique de France 106: 61-83.
- Gilbertson RL, Ryvarden L. 1986. North American polypores. 1. Fungiflora: Oslo (Norway).
- Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol. 2. Fungiflora: Oslo (Norway).
- Hattori T, Ryvarden L. 1993. *Antrodiella aurantilaeta* (*Polyporaceae*, *Basidiomycotina*), a new polypore from Japan. Transactions of the Mycological Society of Japan 34: 363-368.
- Hattori T, Ryvarden L. 1994. Type studies in the *Polyporaceae* 25. Species described from Japan by R. Imazeki and A. Yasuda. Mycotaxon 50: 27-46.
- Johannesson H, Renvall P, Stenlid J. 2000. Taxonomy of *Antrodiella* inferred from morphological and molecular data. Mycol. Res. 104: 92-99.
- Miettinen O, Niemel  T, Spirin W. 2006. Northern *Antrodiella* species: the identity of *A. semisupina*, and type studies of related taxa. Mycotaxon 96: 211-239.

- Niemelä T. 1982. Taxonomic notes on the polypore genera *Antrodiella*, *Daedaleopsis*, *Fibuloporia* and *Phellinus*. *Karstenia* 22: 15-20.
- Piątek M. 2001. The genus *Antrodiella* (*Fungi*, *Poriales*) in Poland. *Polish Botanical Journal* 46:183-190.
- Ryvarden L. 1984. Type studies in the *Polyporaceae* 16. Species described by J.M. Berkeley, either alone or with other mycologists from 1856 to 1886. *Mycotaxon* 20: 329-363.
- Ryvarden L. 1987. New and noteworthy polypores from tropical America. *Mycotaxon* 28: 525-541.
- Ryvarden L. 1990. Type studies in the *Polyporaceae* 22. Species described by C.G. Lloyd in *Polyporus*. *Mycotaxon* 38: 83-102.
- Ryvarden L. 1992. On *Irpex zonatus*. *Boletín de la Sociedad Argentina de Botánica* 28: 227-231.
- Ryvarden L, Gilbertson RL. 1984. Type studies in the *Polyporaceae* 15. Species described by L. O. Overholts, either alone or with J. L. Lowe. *Mycotaxon* 19: 137-144
- Ryvarden L, Gilbertson RL. 1993. European polypores. *Synopsis Fungorum* 6. Fungiflora: Oslo (Norway).
- Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora: Oslo (Norway).
- Vampola P. 1991. *Antrodiella parasitica*, a new species of polypore. *Česká Mykologie* 45: 10-14.
- Vampola P, Pouzar Z. 1996. Contribution to the knowledge of the Central European species of the genus *Antrodiella*. *Czech Mycology* 49: 21-33.

**NATS truffle and truffle-like fungi 15:
Genea balsleyi sp. nov. (Pyronemataceae),
a new hypogeous ascomycete from New Jersey**

MATTHEW E. SMITH

mesmith@ucdavis.edu

*Department of Plant Pathology, University of California at Davis
Davis CA 95616*

Abstract — *Genea balsleyi* is described from New Jersey, USA. This new species is compared morphologically to other known species of *Genea*, with an emphasis on those from Eastern North America.

Introduction

Genea species are hypogeous, ectomycorrhizal *Pyronemataceae* that produce small dark-colored, globose to irregular ascomata with ellipsoid to subglobose, ornamented ascospores (Moreno-Arroyo et al. 2005, Maia et al. 1996, Pfister 1984, Fontana & Centrella 1967, Gilkey 1939). They are abundant and diverse in Mediterranean oak woodlands and other xeric biomes (Smith et al. 2006, Alvarez et al. 1993, Moreno et al. 1991) but can also be found in mesic forest types (Tedersoo et al. 2006). Of the 13 currently recognized *Genea* species from North America, six have been reported east of the Rocky Mountains: *G. thaxteri* Gilkey, *G. macrosiphon* Gilkey, *G. echinospora* Gilkey, *G. brachytheca* Gilkey, *G. anthracina* Heblack & E.L. Stewart and *G. hispidula* Berk. Most of these taxa appear to be rare and are known from only one or a few specimens, but this apparent rarity is probably due to the small size and cryptic nature of *Genea* ascomata. Collections of a *Genea* species associated with *Quercus rubra* in New Jersey did not match the descriptions of any known taxa; I describe it here as *Genea balsleyi* sp. nov.

Materials and methods

Macroscopic characters, including colors, were described from dried material, notes, and photographs provided by the collector, Rich Balsley of the New Jersey Mycological Society. Microscopic characters were determined from hand-sectioned mounts stained with Cotton Blue, heated over an alcohol lamp, then

rinsed and visualized in de-ionized water. KOH was not used because alkaline solutions dissolve the spore ornaments (Smith et al. 2006). Two-dimensional measurements are given as length by width. For details of molecular procedures and phylogenetic analysis, see Smith et al. (2006).

Species description

Genea balsleyi M.E. Sm. sp. nov.

FIG. 1–2

MYCOBANK # MB 510416; GENBANK # DQ218302

Peridium nigrum, pilis destitutum, verrucis rotundatis vel subangulatis 75–150 µm altis x 200–300 µm latis. Asci 180–240 x 2–31 (–33) µm, parietibus tenuibus. Sporae hyalinae, subglobose vel late ellipsoideae, 24–28 (–30) x (20–) 21–25 µm sine ornamento aggregato verrucarum rotundarum, conicarum vel irregularium (2–) 2.5–4.5 (–5) µm altarum, apicibus truncatis vel rotundis. Holotypus Trappe 30528 (OSC130517)

Ascomata hypogeous, subglobose to irregular with lobes and furrows, 7–10 mm high X 8–16 mm broad as dried, hollow, with an apical orifice opening to a single, rounded to irregular chamber. **Peridium** black, lacking obvious surface hairs, with low, rounded to subangular warts 75–150 µm tall x 200–300 µm wide. **Epithecium** lining the ascomatal chamber similar to the peridium, dark grey in fresh specimens but becoming black upon drying. **Mycelial tuft** attached at the base of ascomata, brownish and lighter in color than the peridium

Peridium with two distinct layers. *Outer layer* 150–200 (250) µm thick, of inflated, isodiametric to irregular cells 10–30 x 10–30 (50) µm, with walls varying in thickness 0.5–1.5 (2.5) µm, outer cell layers tending to be larger, with thickened walls ($\pm 2\mu\text{m}$) and darker grey than the inner cells. Outer layer of peridium abruptly differentiated from the *Inner layer*, 80–100 µm thick, composed of hyaline, compressed, isodiametric to elongated, ovoid or irregular cells 3–10 x 10–15 µm with walls ± 0.5 µm thick.

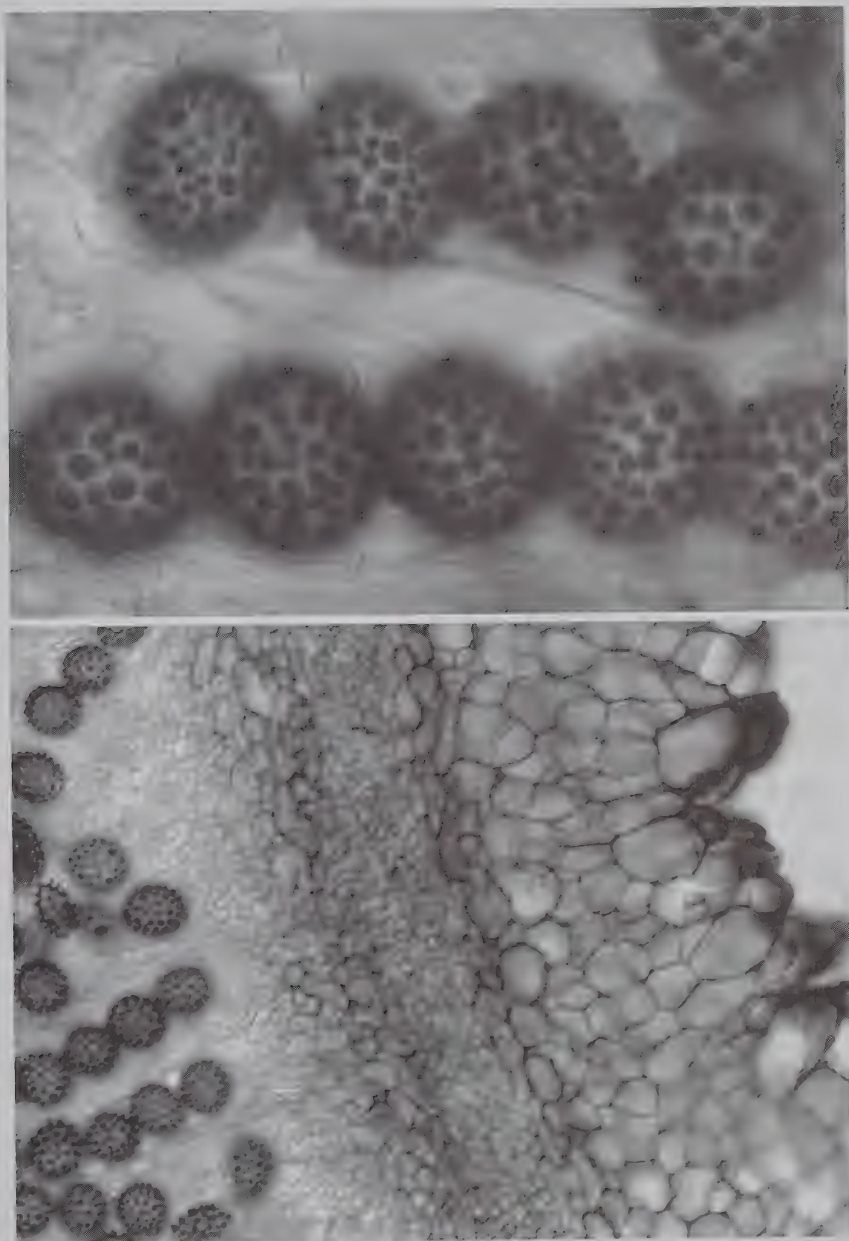
Subhymenium of isodiametric cells, mostly 3–5 x 5–7 (10) µm, with walls, 0.5–1.0 µm thick, less compact than the inner peridial layer.

Asci hyaline, thin-walled, 180–240 x 24–31 (33) µm, mostly 8-spored but in some areas 1-spored.

Paraphyses hyaline, septate, thin-walled, highly variable in width, 3–8 µm wide at the septa, interwoven with one another and surrounded in some areas by rounded to irregular, thin-walled cells 3–5 x 2–5 µm, apparently not connected to the paraphyses themselves, tips exceeding the asci and forming a tissue of small isodiametric cells similar to the subhymenium, abruptly grading to the epithecium.

Epithecium 150–200 (250) µm thick, similar to the peridium.

Spores hyaline, globose to subglobose 24–28 (–30) x (20–) 21–25 µm excluding ornamentation, mean Q (L:W) = 1.21, Q range = 1.0–1.33, (n=20 spores), spore



Figs. 1-2 Holotype collection of *Genea balsleyi* (Trappe30528). Fig. 1. Spores of *G. balsleyi*, scale bar = 10 μ m. Fig. 2. Peridial section and spores of *G. balsleyi*, scale bar = 30 μ m. Note the spore ornamentation of conical to irregular knobs or warts, with truncate to angular tops.

walls 1–2 (2.5) μm thick. **Spore ornamentation** of crowded, conical to irregular knobs or warts, with truncate to angular tops, mostly (2) 2.5–4.5 (5) $\times$ (1.5) 2–4 (5) μm , sometimes two or more conical warts joined at the base to form composite warts with multiple tips.

Etymology in honor of Mr. Rich Balsley, avid amateur mycologist and the collector of all known specimens of *G. balsleyi*.

Distribution, habitat, and season — *Genea balsleyi* is known from three collections in Northern New Jersey. All of the collections were associated with *Quercus rubra* (red oak), the presumed ectomycorrhizal host.

Collections examined — **Holotype**: USA, NEW JERSEY: Passaic Co., Patterson, Rich Balsley. Trappe30528. 28 September 2004. (OSC130517). **Paratypes**: UNITED STATES, NEW JERSEY: Hunterdon Co., Lebanon, R. Balsley. Trappe28214. 24 September 2003 (OSC111704) (GenBank DQ218302). Trappe30679. August 2001. (OSC130518)

Discussion

Genea balsleyi can be distinguished from other eastern North American *Genea* species by a combination of characters including a black peridium lacking surface hairs and spores 28–24 $\times$ 25–21 μm , ornamented with angular warts up to 4.5 μm high. Three of the eastern North American species, *Genea echinospora*, *G. macrosiphon*, and *G. thaxteri*, are easily differentiated from *G. balsleyi* by the brown coloration of their peridia (Gilkey 1939). Whereas the two black-colored species resemble *G. balsleyi* macroscopically, both differ in microscopic characters. *Genea anthracina*, thus far known only from Minnesota, has smaller spores than *G. balsleyi*, with hemispherical ornaments up to 4 μm high (Stewart & Heblack 1979). *Genea brachythea* has scattered dark, septate hairs on the peridium and exceptionally crowded spore ornaments that are shorter than those of *G. balsleyi*. *Genea hispidula*, a European species reported from the Northeastern U.S., has a dense tomentum on the surface of the peridium and spores up to 35 μm long (Montecchi & Sarasini 2000, Gilkey 1939).

Of the *Genea* species from Western North America, *Genea balsleyi* most closely resembles the black-colored species, *G. gardneri* Gilkey, *G. harknessii* Gilkey, and *G. bihymeniata* M.E. Sm. & Trappe. However, *G. gardneri* has larger spores with broader spore ornaments, *G. harknessii* has irregularly shaped spore ornaments with pointed, forked, or anvil-shaped tips, and *G. bihymeniata* has slightly shorter spores and notably rounded spore ornaments (Smith et al. 2006, Gilkey 1939). Previous phylogenetic analysis of 28S rDNA showed that none of these species were closely related to *Genea balsleyi*; it was instead more closely allied to an immature specimen of an undescribed *Genea* species from California (*Genea* sp. src680, Genbank accessions DQ206849, DQ206967) (Smith et al. 2006).

Subsequent analysis indicates that 28S sequences from both *G. balsleyi* and *Genea* sp. (src680) appear similar to those obtained from a European specimen of *Genea verrucosa* Vittad. (collection TL6764 in Herbarium Botanical Museum and Library, University of Copenhagen, GenBank accession AJ969624 – Tedersoo et al., 2006). *Genea balsleyi* is morphologically similar to *G. verrucosa* judging from published descriptions (Moreno-Arroyo et al 2005, Montecchi & Sarasini 2000, Lange 1956), but *G. verrucosa* has shorter, pointed spore ornaments (1–3 µm high) and more ellipsoid spores. Examination of Swedish specimens of *G. verrucosa* at the University of Michigan Herbarium (MICH – L.E.Kers 6038, L.E.Kers 6045) corroborated the morphological differences between *G. verrucosa* and *G. balsleyi*.

Acknowledgements

I thank R. Balsley for providing photographs, basic descriptions and specimens of *Genea balsleyi*. Many thanks are due to P. Rogers and the University of Michigan Herbarium for facilitating access to *Genea* specimens at MICH. K. Hansen provided access to the 28S DNA sequence of *Genea verrucosa* before it was publicly available. J.M. Trappe provided invaluable taxonomic expertise as well as the Latin description. D.M. Rizzo provided access to light and dissecting microscopes and offered editorial advice. This research was also supported by grants to M. E. Smith by the Mycological Society of America (A.H. and H.V. Smith Research Fund & the Forest Ecology Award), San Francisco Mycological Society, Sonoma County Mycological Society (SOMA), and the North American Truffling Society (NATS).

Literature cited

- Alvarez IF, Parlade J, Trappe JM, Castellano MA. 1993. Hypogeous mycorrhizal fungi of Spain. *Mycotaxon*. 47:201–217.
- Fontana A, Centrella E. 1967. Ectomicorriche prodotte da funghi ipogei. *Allionia* 13: 149–176.
- Gilkey HM. 1939. Tuberales of North America. *Oregon State College Studies in Botany*. 1:1–63.
- Lange M. 1956. Danish Hypogeous Macromycetes. *Dansk Botanisk Arkiv*. 16: 28–33.
- Maia LC, Yano AM, Kimbrough JW. 1996. Species of *Ascomycota* forming ectomycorrhizae. *Mycotaxon*. 57:371–390.
- Montecchi A, Sarasini M. 2000. Funghi Ipogei D'Europa. 109–131. Fondazione Centro Studi Micologici dell'AMB. Vicenza, Italy.
- Moreno G, Galan R, Montecchi A. 1991. Hypogeous fungi from peninsular Spain II. *Mycotaxon*. 42: 201–238.
- Moreno-Arroya B, Fernández JG, Calmaestra EP. 2005. Tesoror de Nuestros Montes. Trufas de Andalucía. Gráficas Galán, Córdoba.
- Pfister DH. 1984. *Genea-Jafneadelphus* – a Tuberalean-Pezizalean connection. *Mycologia*. 76:170–172.
- Smith ME, Trappe JM, Rizzo DM. 2006. *Genea*, *Genabea* and *Gilkeya* gen. nov.: ascomata and ectomycorrhiza formation in a *Quercus* woodland. *Mycologia*. 98: 699–716.
- Stewart EL, Heblak RK. 1979. Hypogeous fungi of Minnesota: *Genea anthracina* sp. nov. *Mycotaxon*. 9:451–458.

- Tedersoo L, Hansen K, Perry BA, Kjølner R. 2006. Molecular and morphological diversity of peizalean ectomycorrhiza. *New Phytologist*. 170: 581–596.

The world's second record of *Hyalodictyum colchicum* reported from Turkey

MAKBULE ERDOĞDU & ELŞAD HÜSEYİN

elsadhuseyin@hotmail.com

*Ahi Evran University, Arts and Sciences Faculty
Kırşehir, 40100, Turkey*

Abstract— *Hyalodictyum colchicum*, a rare coelomycete, is reported and illustrated from Turkey on *Quercus pubescens*. This is only the second locality reported for this fungus.

Key words— anamorphic fungi, morphology

Introduction

The flora of Turkey is very diverse and a lot of studies on higher plants have been carried out. However, research on microfungi on plants is poor in Turkey. First data on micromycetes, including coelomycetes, were recorded by Bremer et al. (1947, 1952) and Petrak (1953). Data concerning coelomycetes were subsequently published as information on diseases of cultivated plants (Karel 1958) and results of a fungal diversity study (Göbelez 1967). Investigation of coelomycetes of Turkey has increased during the last decade (Altan & Tamer 1996, Hüseyinov & Selçuk 1999, Braun et al. 2000, Hüseyinov 2000, Hüseyin & Selçuk 2001, Hüseyinov et al. 2002, Selçuk et al. 2003, Mel'nik et al. 2004, Kırbağ 2004, Hüseyin et al. 2005).

Material and methods

The plant material for this paper was collected from the Küre Mountain National Park in Kastamonu province (Black Sea Region) in September 2005.

Specimens of the fungus were taken to the laboratory and microscopically examined under the Leica compound microscope. Sections were hand cut using a razor blade. The fungus was identified using the relevant literature (Woronichin 1916, Jaczewski 1917, Vassiljevsky & Karakulin 1950, Sutton 1980, Mel'nik 1997).

Host plant was identified using the "Flora of Turkey and East Aegean Islands" (Davis 1982). The author abbreviations of fungi are according to Kirk & Ansell

(2004). All examined specimens are deposited in the Ahi Evran University, Arts and Sciences Faculty, Department of Biology, in Kırşehir province of Turkey.

Results

The description and illustration of *Hyalodictyum colchicum* given below are based on the Turkish collections of the material.

Hyalodictyum colchicum Woron. Bull. Mus. Caucase, 10: 30-32, 1916.

Spots visible on both sides of leaves, generally circular or irregularly rounded, 0.3–1.5 cm diam., sometimes elongated, 1.5–3.5 x 0.8–2 cm, brown on the upper surface, fuscous-chestnut on the lower, spots margin yellow (Fig 1A). **Conidiomata** acervular, epiphyllous, pale brown to nectareous, textura angularis, epidermal to subepidermal, rounded, 95–125 µm diam., dehiscence irregular (Fig.1B). **Conidiophores** filiform, hyaline, septate, 6.5–17.5 x 2.5–3.5 µm. **Conidiogenous cells** holoblastic, determinate, integrated, cylindrical, hyaline, 2.9–3.8 x 2.5–2.9 µm (Fig. 2A). **Conidia** acrogenous, hyaline or slightly greenish, muriform, with 3–7 transverse and 1–3 longitudinal septa (? distoseptate), slightly constricted, elliptical, oblong, ovate, pyriform, reniform to irregular, both ends obtuse, 22.5–30 x 15–17.5 µm (Fig. 2B).

Specimen examined—TURKEY, Kastamonu Prov., Küre Mountain National Park, Azdavay district, on living leaves of *Quercus pubescens* Willd. (Fagaceae), 41°41'22"N, 33°10'33" E, 865 m, 1-XI-2005, Co. HUSEYIN E and ERDOĞDU M (ME 1761) .

Discussion

The genus *Hyalodictyum* was described by Woronichin (1916: 30-32) as a monotypic genus with the type species *H. colchicum* Woron. The fungus was collected on leaves of *Quercus hartwissiana* and *Q. iberica* from Georgia (Abhasia). Jaczewski (1917: 784) noted the fungus on living leaves of *Q. iberica* only and gave a very short description that repeated in general the original one. Later Vassiljevsky & Karakulin (1950: 450) gave an interpretation of the genus and species and discussed the basal conidiogenous layer formation between leaf cells. However, Jaczewski and Vassiljevsky & Karakulin did not examine the specimens of *H. colchicum*. They just described the fungus according to the description of Woronichin. Sutton (1980: 172) presented the traditional short description of *Hyalodictyum* with *H. colchicum*, but added the presumed characteristics of conidiogenous cells on the basis of Woronichin's drawings (1916). The type collections of *H. colchicum* are supposed to be lost. Mel'nik (1997) searched for some specimens of the fungus and finally investigated some duplicate type material from the LEP (the Reference collection of the All-Russian Institute of Plant Protection, Russia) without succeeding in finding

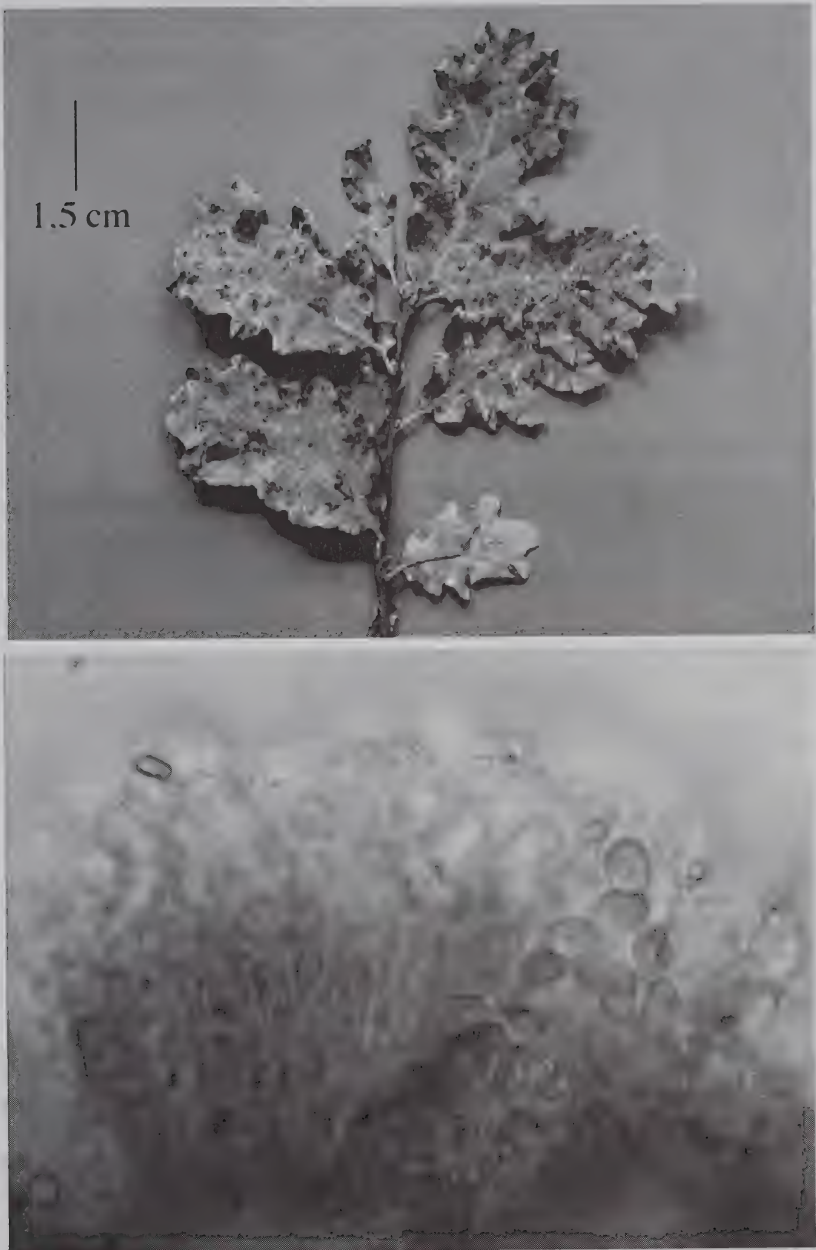


Fig 1. *Hyalodictyum colchicum*:
A.-leaf spots; B.- vertical section of a conidioma. x 200.

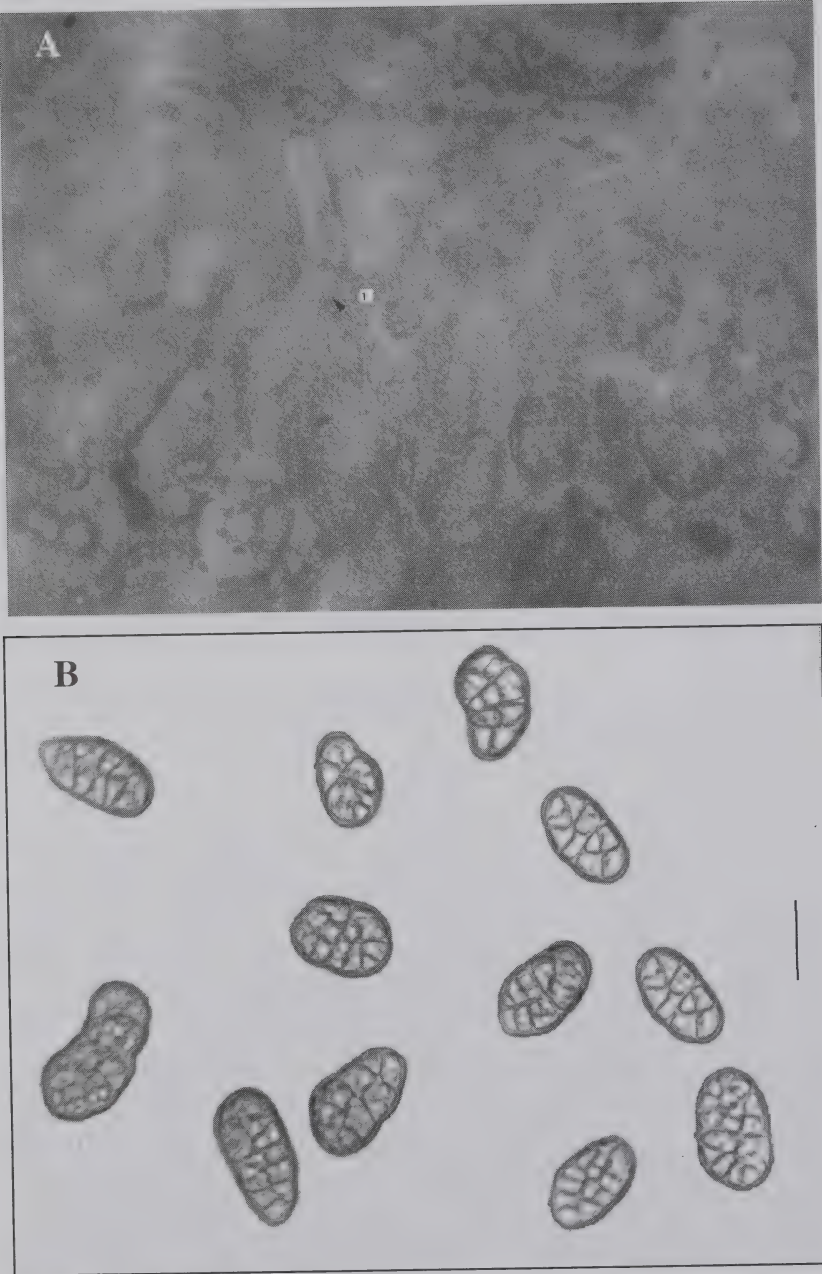


Fig. 2. *Hyalodictyum colchicum*:
A.-Conidiophores and conidiogenous cells. x 1000; B.- natural conidia. Scale bar=20 µm.

fruit bodies of the fungus. He gave a consolidated description of *H. colchicum* based on all previous publications.

The description of *H. colchicum* provided based on the recently collected material from Turkey is more detailed. Many characters agree with existing descriptions of *H. colchicum* (Woronichin 1916, Jaczewski 1917, Vassiljevsky & Karakulin 1950, Sutton 1980, Mel'nik 1997). Nevertheless, some characters are different. Conidiomata measure 95–125 µm diam., falling in the mid-range of the dimensions according to Woronichin (1916), about 60–150 µm. Conidia are hyaline or slightly greenish in the Turkish specimen (not only hyaline as in original diagnosis), 22.5–30 x 15–17.5 µm. According to Woronichin (1916), the conidia are narrower 22–30 x 10–15 µm.

Acknowledgements

The authors would like to extend a sincere gratitude to Dr. Tetiana V. Andrianova (Kiev, Ukraine) and Dr. Shaun Pennycook (Auckland, New Zealand) for linguistic help and critique of the manuscript. We also thank Dr. Dasha Belomesyatseva (Minsk, Belarus) for critically reading the manuscript and serving as presubmission reviewers.

Literature Cited

- Altan Y, Tamer AÜ. 1996. The parasitic fungi occurring on some endemic plants in Turkey and their damaging effects. Plant life in South-West and Central Asia. Ege University Pres, İzmir Turkey, pp. 398-401.
- Braun U, Mel'nik V, Hüseyinov E, Selçuk F. 2000. *Mycopappus alni* on species *Betula* and *Pyrus* from Turkey. Mikologia i Fitopatologia 34 (6): 1-2.
- Bremer H, Ismen H, Karel G, Özkan M. 1947. Beiträge zur Kenntnis der parasitischen Pilze der Türkei. I. Revue de la Faculté des Sciences de l'Université d'Istanbul. Ser. B. 12(2): 307-334.
- Bremer H, Karel G, Biyikoğlu K, Göksel N, Petrak F. 1952. Beiträge zur Kenntnis der parasitischen Pilze der Türkei. VI. Revue de la Faculté des Sciences de l'Université d'Istanbul. Ser. B. 17(3): 259-275.
- Davis PH. (Ed.). 1982. Flora of Turkey and East Aegean Islands. Vol. 7. Edinburgh University Press, Edinburgh. 1-947 pp.
- Göbelez M. 1967. La Mycoflore de Turquie. II. Mycopathologia et Mycologia Applicata 23(1): 47-67.
- Hüseyin E, Selçuk F. 2001. New and poorly known genera of microfungi for Turkey. Turk. J. Bot. 25 (6): 437-438.
- Hüseyin E, Selçuk F, Gaffaroğlu M. 2003. Some materials on mitosporic fungi from Turkey. I. *Hyphomycetes*. Botanica Lithuanica 9(2): 151-160.
- Hüseyin E, Selçuk F, Sahin A. 2005. The world's second record of *Neoheteroceras flageoletii* reported from Turkey. Mycotaxon 94 (4): 241-244.
- Hüseyinov E. 2000. New records of microfungi for Turkey. Israel Journal of Plant Sciences 48 (1): 75-78.
- Hüseyinov E, Selçuk F. 1999. New records of phytopathogenic microfungi for Turkey. Plant Disease Research 14 (2): 175-176.

- Hüseyinov E, Mel'nik V, Selcuk F. 2002. *Ceratophorum helicosporum* – a new for mycoflora of Turkey genus and species of Hyphomycetes (*Dematiaceae*). Mikologia i Fitopatologia 36 (3): 11-13.
- Jaczewski AA. 1917. Opredeletel' gribov. T. 2. Nesovershennyye griby. Petrograd, Publishing House of S.L. Kind. 1-803 pp.
- Karel GA. 1958. A Preliminary List of Plant Disease in Turkey. Ayyıldız Matb, Ankara. 44 pp.
- Kırbağ S. 2004. New records of microfungi from Turkey. Pak. J. Bot. 36 (2): 445-448.
- Kirk PM, Ansell AE. 2004. Authors of fungal names. Electronic version, CAB International, Wallingford UK. (www.indexfungorum.org/Names/AuthorsOffungalNames.asp)
- Mel'nik VA. 1997. Definitorium fungorum Rossiae. Classis Coelomycetes, Fasc. 1 Genera rara et minus cognita (Opredeletel' Gribov Rossii Klass Coelomycetes Vyp. 1. Redkie i Maloizvestnye Rody). Nauka, Petropoli. 1-280 pp.
- Mel'nik V, Hüseyin E, Selcuk F. 2004. Contribution to the studying of micromycetes in several Black Sea Provinces of Turkey. Novitates Systematicae Plantarum non Vascularum (Novosti Systematiki Nizshih Rasteniy) 37: 133-148. Nauka: Petropolis.
- Selcuk F, Hüseyin E, Bitmiş K. 2003. Some materials on mitosporic fungi from Turkey. II. *Coelomycetes*. Botanica Lithuanica 9 (2): 161-170.
- Sutton BC. 1980. The Coelomycetes. Fungi Imperfecti with pycnidia, acervuli and stromata. CMI, Kew. 696 pp.
- Petrak F. 1953. Neue Beitrage zur Pilzflora der Turkei. Sydowia 7 (1-4): 14-44.
- Vassiljevsky NI, Karakulin BP. 1950. Fungi Imperfecti Parasitici. Pars II. *Melanconiales*. Publishing House of Academy of Sciences, Moscow, Leningrad. 1-680 pp.
- Woronichin NN. 1916. Materialy k mikologicheskoy flore Kavkaza. III. Griby iz kollektsii Kavkazskogo Muzeya. Izvestiya Kavkazskogo Museya 10:1-35.

The genus *Ganoderma* (Basidiomycota) in Iran

MOHAMMAD FATA MORADALI¹*, GHORBAN ALI HEDJAROUDE¹,
HOSSEIN MOSTAFAVI², MEHRDAD ABBASI³,
SHIRIN GHODS¹ & ABBAS SHARIFI-TEHRANI¹

*fmoradali@excite.com

¹Plant Protection Dept., Faculty of Horticultural Science & Plant Protection
Agriculture & Natural Resources College, Tehran University,
Karaj, Iran

²Organic Chemistry & Biochemistry Dept., Faculty of Chemistry
Tabriz University, Tabriz, Iran

³Plant Pest & Diseases Research Institute
Tehran, Iran

Abstract — The genus *Ganoderma* was investigated in Iran. Based on micro- and macromorphology and host relationships, descriptions are made and a key to the identification of the Iranian species provided. Seven species of *Ganoderma* were found in Iran, viz. the three non-laccate species *G. applanatum*, *G. adspersum*, and *G. colossus* and the four laccate species *G. lucidum*, *G. resinaceum*, *G. tsugae* and *G. manoutchehrii*.

Key words — basidiocarp, morphology, taxonomy, basidiospore, *Elfvigia*

Introduction

The genus *Ganoderma* P. Karst. has been known for over 100 years and was introduced by Karsten (1881) based on *Polyporus lucidus*. On the basis of the unique feature of the double-walled basidiospore, Patouillard (1889) described in or transferred into *Ganoderma* a number of species and published a monograph accepting 48 species. He distinguished also the species with globose or subglobose spores as section *Amauroderma*.

Many species belonging to the genus *Ganoderma* were reported by Patouillard (1889), Boudier & Fischer (1894), Boudier (1895), Murrill (1902, 1908) and other taxonomists. Boudier & Fischer (1894) and Boudier (1895) described *G. valesiacum* Boud. from conifers in Europe. Murrill (1902, 1908) published a synopsis of the species occurring in North America. He described seven new temperate species including *G. tsugae*, *G. sessile* Murrill, *G. zonatum*

Murrill, *G. sulcatum* Murrill, *G. oregonense* Murrill, *G. sequoiae* Murrill and *G. nevadense* Murrill, along with 10 others from tropical areas. The identification of *Ganoderma* was by then mainly based on host specificity, geographical distribution, and macromorphological features of the fruitbody, including the color of the context and the shape of the margin of the pileus and whether the fruit body was stipitate or sessile. Murrill (1902, 1908) considered primary taxonomic characters to be host specificity, geographical distribution, and macromorphology of the fruiting body. Atkinson (1908), Ames (1913), Haddow (1931), Overholts (1953), Steyaert (1972, 1975, 1977, 1980), Bazzalo & Wright (1982), and Corner (1983) conducted the identification of *Ganoderma* species by morphological features from a geographically restricted set of specimens. Haddow (1931) and Steyaert (1980) emphasized the basidiospore and hyphal characteristics as key features for the taxonomy of this group. Steyaert (1961a,b, 1962, 1967a, b, 1972, 1980) also investigated the world taxa while evaluating the value of both macro- and micromorphological features and described several new taxa most of which he later reduced to synonymy.

According to Ryvarden (1991), the genus is in a state of taxonomic chaos. Different authors use diverse criteria for the taxonomy of these fungi. This lack of unifying criteria contributed to the difficulty of harmonizing the taxonomy of this group. Recent workers have used characters other than morphology to determine relationships within the genus. These have included, in the first instance cultural and mating characters (Adaskaveg & Gilbertson 1986), isozyme studies (Hseu 1990, Gottlieb & Wright 1999), and more recently ribosomal DNA sequence and cladistic methods (Moncalvo et al. 1995) to infer natural relationships. With the development of cladistic methods to reconstruct phylogeny, the possible resolution of some of these problems appears close to hand.

The family *Ganodermataceae* was erected for polypores having a double-walled basidiospore (Donk 1964). Two kinds of basidiocarps producing this type of basidiospore have been distinguished: those with a shiny (laccate), yellowish or reddish-brown to black pilear surface, and those with a dull (non-laccate), grey-brown to black pilear surface (Moncalvo 2000). The genus *Elfvigina* P. Karst. was created to accommodate non-laccate *Ganoderma* taxa with *Boletus applanatus* as the type species (Karsten 1889). Modern authors such as Corner (1983) and Ryvarden (1991) treat *Elfvigina* as a subgenus of *Ganoderma*.

Seven species of *Ganoderma* have been previously recorded from Iran (Steyaert 1972; Saber & Minassian 2000; Moradali et al. 2004; Arefipour et al. 2002, 2004). They are re-described here in more details based on macro- and micromorphological features (Table 1). Their distributions throughout Iran are shown in Figure 1.



Figure 1- Biogeographical vegetation domain of *Ganoderma* species for Iran: *G. lucidum* (*); *G. resinaceum* (+); *G. tsugae* (★); *G. applanatum* (▲); *G. adpersum* (◆); *G. colossus* (●); *G. manoutchehrrii* (⊙).

Materials and methods

In this study we examined herbarium specimens from Herbarium of the Ministry of Jihad-e Keshavarzi (IRAN) and newly collected materials from Northern Iran.

Basidiospores were observed by light microscopy, using 3% KOH, Melzer's reagent and Lactophenol. Spore length and width were determined by ocular micrometer for 20 spores from the fruitbody. Sections of the cutis and tube layer were obtained with a freezing microtome and their elements were observed by using 3% KOH, Melzer's reagent and Lactophenol. Pigments covering the elements of cutis were washed by Acetone solvent. Amyloid or non-amyloid reaction was observed in Melzer's reagent (Kirk et al. 2001, where the recipe can be found). Drawings were made with a drawing tube on a Zeiss microscope.

Table 1- The *Ganoderma* species reported from Iran

Name	Geographical origin	Host/substrate	Reference
<i>G. lucidum</i>	Shast-Klateh	-	Arefipour et al. 2004
	Astara	<i>Parrotia persica</i> <i>Fagus orientalis</i> <i>Alnus</i> sp.	Saber et al. 2000
	Golestan	<i>Fagus</i> sp.	Arefipour et al. 2002
<i>G. resinaceum</i>	Tonekabon	wood	Moradali et al. 2004
	Lahijane	<i>Quercus</i> sp. <i>Parrotia persica</i>	Saber et al. 2000
	Bandar-e-Anzali	<i>Robinia pseudoacacia</i>	Saber et al. 2000
	Rasht	<i>Populus</i> sp.	
	Tonekabon	wood	Moradali et al. 2004
<i>G. tsugae</i>	Gilan	Conifer	Saber et al. 2000
<i>G. applanatum</i>	Golestan	<i>Fagus</i> sp.	Arefipour et al. 2002
	Shast-Klateh	-	Arefipour et al. 2004
	Drazno	-	
	Ahvaz	-	Saber et al. 2000
	Chalous	-	
	Golestan	-	
	Tonekabon	Wood	Moradali et al. 2004
<i>G. adspersum</i>	Dohezar	Wood	
	-	-	Saber et al. 2000
	Astara	-	
<i>G. colossus</i>	Dohezar	<i>Ulmus</i> sp.	Saber et al. 2002
	Dohezar	Wood	Moradali et al. 2004
	Kish Island	<i>Ficus benghalensis</i>	Saber et al. 2000
	Ahvaz	<i>Ziziphus spina-christi</i>	
<i>G. manoutchehrii</i>	Ramsar	<i>Acacia</i> sp.	Steyaert 1972

Key to *Ganoderma* species of Iran

- 1a. Cutis a hymenoderm; context pale, white to pale brown or brown 2
- 1b. Cutis a characoderm; context dark brown 5
 - 2a. (1a) Basidiocarp laccate and context white to pale or dark brown; without chlamydospores 3
 - 2b. Basidiocarp non-laccate, context yellowish to buff; chlamydospores 8.0-12.5 x 13-19.5 µm *G. colossus*
- 3a. (2a) Context dark cinnamon brown; basidiospores 6.7-11.5 x 5.7-7.6 µm *G. resinaceum*
- 3b. Context white to pale brown or yellowish; basidiospores longer than 9 µm 4

- 4a. (3b) Context white to brownish; carpophore brownish orange to black; on coniferous trees; basidiospores $9-11 \times 6-8 \mu\text{m}$ *G. tsugae*
- 4b. Context pale brown to yellowish; carpophore reddish brown to black; on angiosperms; basidiospores $10.5-13.4 \times 6.7-9.6 \mu\text{m}$ *G. lucidum*
- 5a. (1b) Basidiocarp non-laccate, with or without hyaline hyphae in cutis 6
- 5b. Basidiocarp laccate with hyaline hyphae in cutis *G. manoutchehrri*
- 6a. (5a) Cutis with hyaline hyphae; basidiospores $8.6-10.5 \times 5.7-7.6 \mu\text{m}$ *G. adspersum*
- 6b. Cutis without hyaline hyphae; basidiospores $7.6-11.5 \times 5.7-6.7 \mu\text{m}$ *G. applanatum*

Taxonomy

Ganoderma applanatum (Pers.) Pat. Hyménomyc. Eur. (Paris): 143, 1887 Figs. 2-3

= *Boletus applanatus* Pers., Obs. Mycol. 2: 2, 1800 ('1799').

= *Polyporus applanatus* (Pers.) Wallr., Fl. Crypt. Germ. 2: 591, 1833.

= *Elfvigia applanata* (Pers.) P. Karst., Bidr. Känn. Finl. Nat. Folk 48: 334, 1889.

= *Polyporus megaloma* Lév., Annls Sci. Nat. (Bot.) III 5: 128, 1846.

= *Polyporus leucophaeus* Mont., Syll. Crypt. p. 157, 1856.

Key characters — Basidiocarp perennial, woody, typically sessile, up to $35 \times 26 \times 9$ cm, fan-shaped to slightly convex, usually solitary but also connected with each others; margin rounded early and becoming narrowed at maturity; surface a hard crust, brown to grey brown, dull grey, irregular, often furrowed, nodulose and zonate, often dusted with brown spores, crust thick, of characodermis type with irregular hyphal elements; context up to 6.0 cm thick, brown to dark brown, veined with white mycelia, tough, corky; pore 4-5 per mm, pore surface at first white, becoming grey-brown at maturity and quickly bruising brown when injured, fading to pale yellowish-buff when dried, most specimens with several tube layers (up to 6 layers) separated by thin layers of brown tissue.

Basidiospores ovoid to broadly ellipsoid, with a truncate apex, thick and double-walled, brown, spinulose, $5.7-6.7 \times 7.6-10.5-11.5 \mu\text{m}$. Hyphal system trimitic with hyaline, thin-walled, septate, clamped generative hyphae, $1-2 \mu\text{m}$ in diam., skeletal hyphae golden brown, thick-walled, aseptate, very long, $4-6 \mu\text{m}$ in diam. and binding hyphae profusely branched, thinner and lighter than the skeletal, aseptate, limited growth, $1-4 \mu\text{m}$ in diam.

Habitat — This species grows solitary or in small groups almost always on fallen logs of both hardwood and conifers, but also on living trees as a weak parasite, penetrating through injured tissue and causing a white rot.

Material examined— On fallen logs of hardwood, Kotra, Tonekabon, Mazandaran, April 21, 2003 (IRAN 1538 F); on fallen logs of hardwood, Dohezar forest, Tonekabon, April 21, 2003 (IRAN 1527 F); on fallen logs of hardwood, Mazoben, Kotra, Tonekabon, July 21, 2003 (IRAN 1528 F); on fallen logs, Namak-Abroud forest, Chalous, Mazandaran, July 30, 2003 (IRAN 2100 F).



Figure 2- Macro- and micromorphological characteristics of *Ganoderma applanatum*.
a, basidiocarp; b, pore surface; c, cutis elements; d, basidiospores

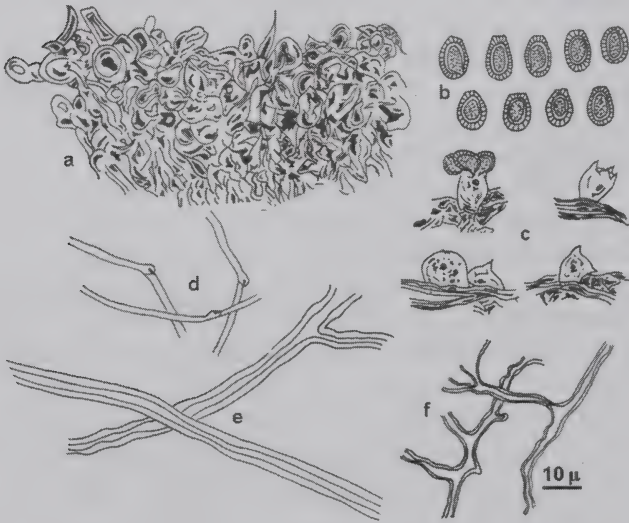


Figure 3- Basidiocarp characteristics of *Ganoderma applanatum*.
a, cutis elements; b, basidiospores; c, basidia;
d, generative hyphae; e, skeletal hyphae; f, binding hyphae

Ganoderma adpersum (Schulzer) Donk, Proc. Ned. Akad. Wet., C 72: 273, 1969.

Figs. 4-5

≡ *Polyporus adpersus* Schulzer, Flora 61: 11, 1878.

= *Polyporus linhartii* Kalchbr., in Linhart, Fung. Hong. no. 252, 1884.

≡ *Ganoderma linhartii* (Kalchbr.) Z. Igmándy, Acta Phytopath. Acad. Sci. Hung. 3: 237, 1968.

= *Ganoderma europaeum* Steyaert, Bull. Jard. Bot. Brux. 31: 70, 1961.

Key characters — Basidiocarp perennial, woody, sessile, dimidiate, up to 17 x 16 x 6 cm; pileus brown to dark brown; very hard when dry, zoned with concentric sulcate rings, somewhat cracking when dry, surface a hard crust, cutis 0.9-1.5 mm thick, of characodermis type with irregular hyphal elements also with hyaline hyphae that branch off in the cutis; context relatively thin, up to 4.0 cm thick, dark brown, corky; pore 4-5 per mm, pore surface whitish grey to light brown, fading to pale yellowish-buff when dried; tube layer with lighter color than context, clearly differentiated from the context, without distinct separating context zones between each tube layer and tubes, whitish, up to 1.5 cm thick.

Basidiospores ovoid, with a rounded or truncate apex, thick and double-walled, brown, spinulose, 5.7-6.7-7.6 x 8.6-9.6-10.5 μ m. Hyphal system trimitic with hyaline, thin-walled, septate, clamped generative hyphae, 1-3 μ m in diam., skeletal hyphae golden brown, thick-walled, aseptate, very long, 4-8 μ m in diam. and binding hyphae profusely branched, thinner and lighter than the skeletal hyphae aseptate, limited growth, 2-5 μ m in diam.

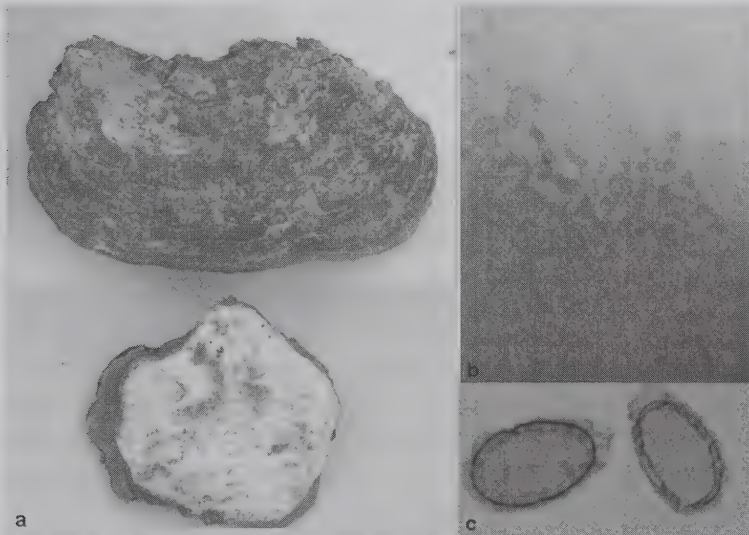


Figure 4- Macro- and micromorphological characteristics of *Ganoderma adpersum*.
a, basidiocarp; b, cutis elements; c, basidiospores

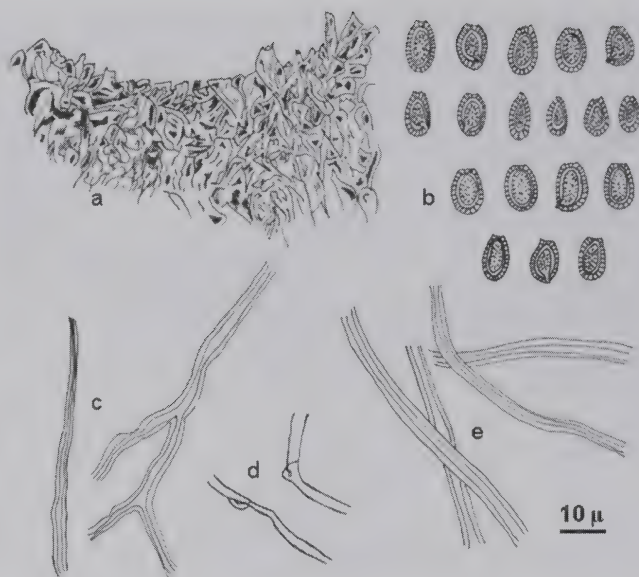


Figure 5 - Basidiocarp characteristics of *Ganoderma adspersum*.

a, cutis elements; b, basidiospores; c, binding hyphae; d, generative hyphae; e, skeletal hyphae

The basidiocarps of *G. applanatum* and *G. adspersum* are sometimes similar to each other. However, the differences between them is clearly seen in their spore dimensions and micromorphology of the cutis, the basidiospores of *G. applanatum* being the smaller. Also there are hyaline hyphae that branch off in the cutis of *G. adspersum*. According to Steyaert's study on the Iranian specimens of *G. adspersum*, it is quoted that they have smaller spores and thinner context than in European specimens (Saber 1973). The context in these specimens is brown and they have white hyphae whereas European specimens have a red context and no white hyphae (Saber 1973). According to Steyaert (Saber 1973), the existence of white hyphae is caused by a facultative parasite, that this species is subject to in the climatic conditions of northern Iran. This difference can arise from their geographical distribution, habitat and behaviour of organisms in each geographical region.

Habitat — This species grows on fallen logs of hardwoods causing a white rot. It has been collected in northern Iran on *Gleditschia caspica*, *Prunus spinosa*, *Citrus aurantium*, *Diospyros kaki*, *Mespilus germanica*, but also on living trees of *Quercus* spp., *Acer* spp. and *Fagus orientalis* (Saber et al. 2000).

Material examined- On fallen log of hardwood tree, Dohezar forest, Tonekabon, Mazandaran, April 22, 2003 (IRAN 1539 F); on dry wood, Gorgan and shamoshak forest, Golestan province, Nov. 2003 (IRAN 311 F).

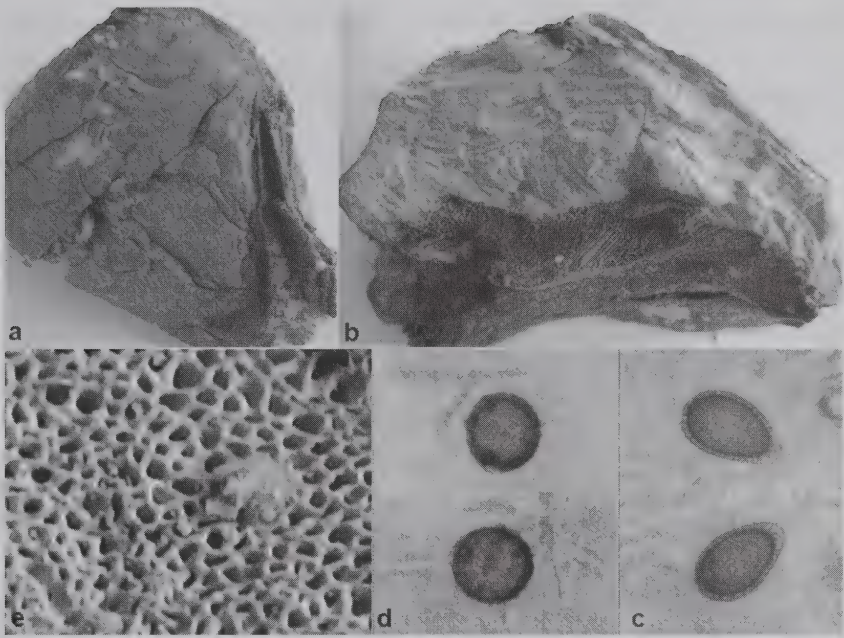


Figure 6 – macro – and micromorphological characteristics of *Ganoderma colossus*.

a, basidiocarp; b, context and tube layer; c, basidiospores; d, chlamydospores; e, pore surface

Ganoderma colossus (Fr.) C.F. Baker, Fung. Malay. no 425, 1918.

Fig. 6

= *Polyporus colossus* Fr., Nova Acta Soc. Sci. Upsal. III 1: 56, 1851.

= *Dendrophagus colossus* (Fr.) Murrill, Bull. Torrey Bot. Club 32: 473, 1905.

= *Tomophagus colossus* (Fr.) Murrill, Torrey 5: 197, 1905.

= *Ganoderma obockense* Pat., Bull. Soc. mycol. Fr. 3: 119, 1887.

= *Polyporus hollandii* Massee, Bull. Misc. Inf. Kew 1901: 163, 1901.

Key characters — Basidiocarp dimidiate, bulky, up to 35 cm in radius and 9 cm thick; pileus tender, soft and upper surface dull to somewhat shiny, yellowish to buff; cutis very thin, dark dull yellow, scaling off easily, of hymeniodermis type with club-shaped elements, about 40 μm long and 7-8 μm thick at the apex; context usually two third of the thickness of the basidioma, chamois; pore surface white at first and dark buff at maturity and when dried; tube layer up to 3.0 cm thick, buff.

Basidiospores ovoid, chamois, double-walled, echinulate with 1 μm long spines along the spore side and up to 4 μm long at the apex, 8-9.7-12.5 x 13-16.3-19.5 μm .

Chlamydospores globose, covered with short, stumpy spines or ridges, chamois, 16-18-21 μm , located irregularly in context; hyphal system dimitic with hyaline, thin-walled, septate, clamped generative hyphae, strongly branched

in the context, 2-4 μm in diam. and skeletal hyphae pale yellow, thick-walled, aseptate, 3-5 μm in diam.

Habitat — This species was collected on *Ficus benghalensis* and on an unknown tree in Kish Island, and on *Ziziphus spina-christi* in Ahvaz, Khuzestan province, both areas situated in southern Iran (Saber & Minassian 2000).

Material examined— On *Ziziphus spina-christi*, Ahvaz, Khuzestan, Nov. 1999 (IRAN 10927 F); on *Ficus benghalensis*, Kish Island, Oct. 1997 (IRAN 10560 F).

Ganoderma lucidum (Curtis) P. Karst., Revue mycol., Toulouse 3(9): 17, 1881

Fig. 7-9

≡ *Boletus lucidus* Curtis, Fl. Lond. 2: pl. 216, 1781.

≡ *Polyporus lucidus* (Curtis) Fr., Syst. Mycol. 1: 353, 1821.

≡ *Placodes lucidus* (Curtis) Quél., Enchir. Fung. p. 170, 1886.

Key characters — Basidiocarp sessile, dimidiate or stipitate either centrally, excentrically or laterally, and then usually reniform, with different sizes, up to 20 x 14 x 1.5 cm; upper surface radially and concentrically plicate, usually irregular, sometimes warty, laccate, shiny, pale red, reddish brown to blackish brown; margin usually thick, sometimes acute, white in actively growing specimens, and turning yellowish, orange, and reddish brown from the extreme outline inward; stem lateral, vertical, cylindrical, usually long, slender, up to 3 cm thick and 27 cm long, reddish black to almost black, laccate, brilliant, and often but not always with a stem; cutis thin, shiny, a hymenoderm with club-shaped elements originating from the ends of skeletal hyphae, arranged in a palisade-like hymenium, up to 10.5 x 62 μm , amyloid in Melzer's reagent or non-amyloid, these elements are covered by a thick layer of a lacquer pigments that dissolve in a hot solution of 5% KOH and acetone; context creamy white to ochraceous brown, corky, about 1.0 cm thick; tube layer about 1.0 cm thick; tube layer darker than context, about 7.0 mm thick; pore surface white at first and turning greyish when mature and dried; pores more or less rounded, somewhat irregular, 4-6 per mm.

Basidiospores ovoid, double-walled, with a rounded or truncate apex, brown, echinulate comparatively few, long and thick, 6.7-8.6-9.6 x 10.5-12.4-13.4 μm . Hyphal system trimitic with hyaline, thin-walled, septate, clamped generative hyphae, 1-3 μm in diam., skeletal hyphae golden brown, thick-walled, aseptate, very long, 3-7 μm in diam. and binding hyphae profusely branched, thinner and lighter than the skeletals, aseptate, limited growth, 2-4 μm in diam.

Habitat — At the base of trunks and on roots of hardwoods, rarely on conifers. Specimens of this species were collected on *Buxus hyrcana*, *Acacia dealbata*, *Pterocarya fraxinifolia*, *Quercus* sp., *Albizia* sp., *Casuarina* sp., *Platanus* sp. (Saber 1973 Saber & Minassian 2000 Saber & Esmailii-Taheri 2004).

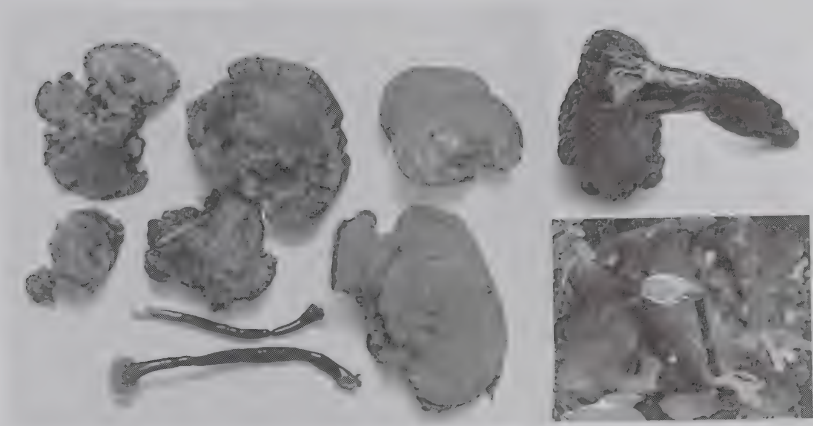


Figure 7- Basidiocarp characteristics of *Ganoderma lucidum*

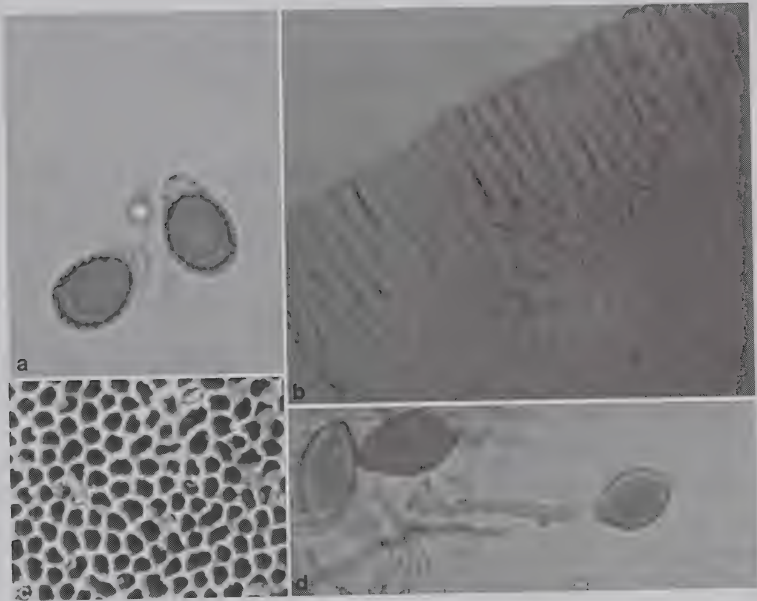


Figure 8- Micromorphological characteristics of *Ganoderma lucidum*.
a, basidiospores; b, cutis elements; c, pore surface; d, chlamydospores

Material examined- On fallen hardwood trunk, Dohezar forest, Tonekabon, Mazandaran, July, 2003 (IRAN 1540 F); on fallen hardwood trunk, Dohezar forest, Tonekabon, Mazandaran, April, 2003 (IRAN 1541 F); on fallen hardwood trunk, Mazoben, Kotra, Tonekabon, Mazandaran, July, 2003 (IRAN 2099 F); on *Carpinus betulus*, Gavsar, Tonekabon, Mazandaran, August 19, 1971 (IRAN 6722 F); on wood, Tonekabon, Mazandaran, summer, 1970 (IRAN 6721 F).

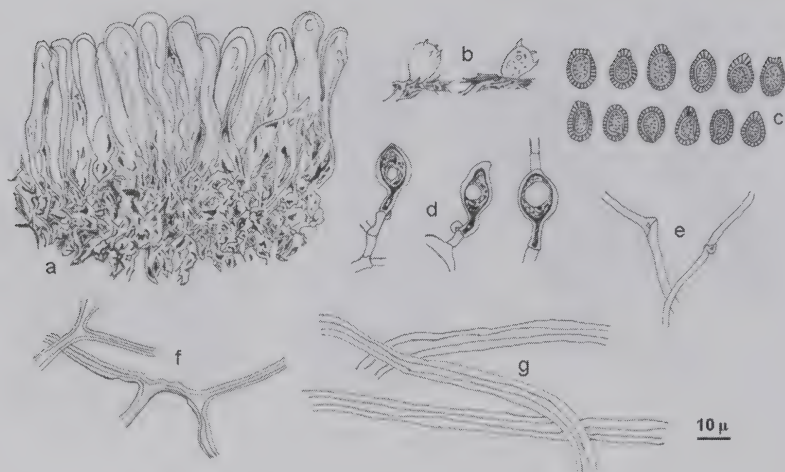


Figure 9 - Basidiocarp characteristics of *Ganoderma lucidum*.
a, cutis elements; b, basidia; c, basidiospores; d, chlamydospores;
e, generative hyphae; f, binding hyphae; g, skeletal hyphae

Ganoderma resinaceum Boud. in Patouillard, Bull. Soc. mycol. Fr. 5: 72, 1889

Figs. 10-11

- = *Ganoderma chaffangeonii* Pat., Bull. Soc. mycol. Fr. 5: 74, 1889.
- = *Ganoderma sessile* Murrill, Bull. Torrey Bot. Club 29: 604, 1902.
- = *Polyporus polychromus* Copel., Ann. Mycol. 2: 507, 1904.
- = *Ganoderma polychromum* (Copel.) Murrill, N. Am. Fl. 9: 119, 1908.
- = *Ganoderma praelongum* Murrill, N. Am. Fl. 9: 121, 1908.
- = *Ganoderma argillaceum* Murrill, N. Am. Fl. 9: 122, 1908.
- = *Ganoderma subperforatum* G.F. Atk., Bot. Gaz. 46: 337, 1908.
- = *Ganoderma platense* Speg., Bol. Acad. Nac. Cienc. Córdoba 28: 363, 1926.

Key characters — Basidiocarp dimidiate to reniform, substipitate to long stipitate, usually laterally, sometimes centrally stipitate; pileus very variable in size, up to 26 x 13 x 5 cm, often very irregular in shape; upper surface applanate, concave or more or less infundibuliform, smooth, irregularly rugose, concentrically sulcate and radially rugose or strongly tuberculose, shiny laccate, reddish brown or light reddish brown in maturity, central zone yellowish brown and very light in young specimens, may have a thick white margin when these are not mature, gradually turning yellow, red, brown and finally black from the margin toward the base; stem very short to long, lateral or central, slender to thick, black, laccate, brilliant; cutis thin, 100 μm, shiny black, a hymenoderm with club-shaped elements originating from the ends of the skeletal hyphae, arranged in a palisade-like hymenium, up to 22 x 57 μm, amyloid in Melzer's reagent; context corky, cinnamon brown in the upper parts

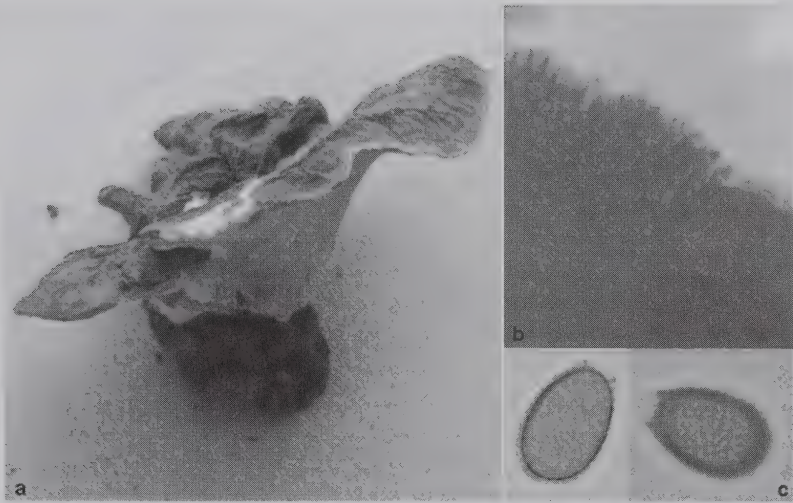


Figure 10- Macro- and micromorphological characteristics of *Ganoderma resinaceum*.
a, basidiocarp; b, cutis elements; c, basidiospores

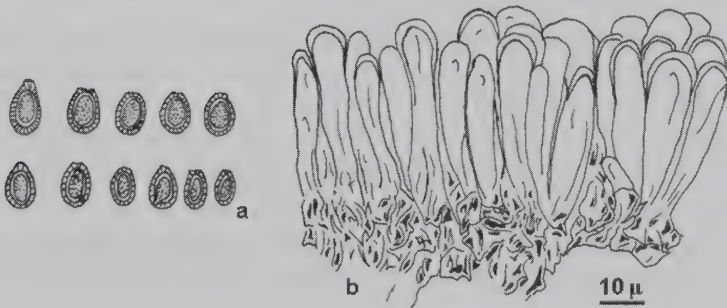


Figure 11 - Basidiocarp characteristics of *Ganoderma resinaceum*.
a, basidiospores; b, cutis elements

but with zone closed to tube layer cacao brown; tube layer slightly lighter than context, about 4-15 mm thick; pore surface white at first turning greyish when mature and dried; pores rounded, somewhat irregular, 4-6 per mm.

Basidiospores ellipsoid, double-walled, with a rounded or truncate apex, chamois, with short, thin, closely packed spines, thus appearing smooth when observed at 400 x, $5.7-6.7-7.6 \times 6.7-11.5 \mu\text{m}$. Hyphal system trimitic with hyaline, thin-walled, septate, clamped generative hyphae, 1-5 μm in diam., skeletal

hyphae golden brown, thick-walled, aseptate, very long, mostly unbranched or with one or two distal branches besides some lateral swellings, 3-7 μm diam. and binding hyphae branched, thinner and lighter than the skeletal hyphae, aseptate, limited growth, much branched, 2-4 μm in diam.

Habitat — On trunks and fallen logs of hardwoods and conifers. *Quercus* sp., *Robinia pseudoacacia* and *Populus* sp. are its hosts in Iran (Saber & Minassian 2000).

Material examined- On fallen trunk, Gisum Park, Gilan, Iran, June 21, 1991 (IRAN 10685 F).

Ganoderma tsugae Murrill, Bull. Torrey Bot. Club 29: 601, 1902

Fig. 12

= *Polyporus tsugae* (Murrill) Overh., Ann. Mo. Bot. Gard. 2: 714, 1915.

Key characters — Basidiocarp reniform or flabelliform, stipitate or narrowed to an almost sessile base, corky; pileus variable in size, up to 20 x 30 x 5 cm, brownish orange to blackish, shiny laccate, paler on the margin, sometimes with a brown coating of spores, azonate or somewhat zonate or sulcate on the margin; stem when present usually lateral, sometimes central with color as in the pileus or more shining, 3-5 cm; cutis thin, shiny red, a hymenoderm; context tough and watery when fresh, white or nearly so throughout but usually slightly brownish next to the tube, 0.5-2.5 cm thick; pore surface white to brown, tube layer 0.5-1 cm thick; pores 4-6 per mm.

Basidiospores ovoid, double-walled, with a truncate apex, light brown, apparently echinulate, 6-8 x 9-11 μm . Hyphal system trimitic with hyaline, thin-walled, septate, clamped generative hyphae, 1-3 μm in diam., skeletal hyphae pale brown, thick-walled, aseptate, 4-6 μm in diam. and binding hyphae branched, thinner and lighter than the skeletals, aseptate, 2-4 μm in diam.

Habitat — On logs and living trees of conifers.

Material examined- On conifer, Gisom-Rezvanshahr, Gilan province, July 1997 (IRAN 10843 F); on wood, 10 Km Fuman to Masuleh, Gilan province, May 1996 (IRAN 10782 F).

Ganoderma manoutchehrii Steyaert, Persoonia 7(1): 71, 1972

This species was described by Steyaert (1972) based upon a single specimen on *Acacia* sp., collected from Ramsar (Northern Iran). The holotype was not available for us to check. We also visited type locality of above species several times to find topotype but no specimen was found.

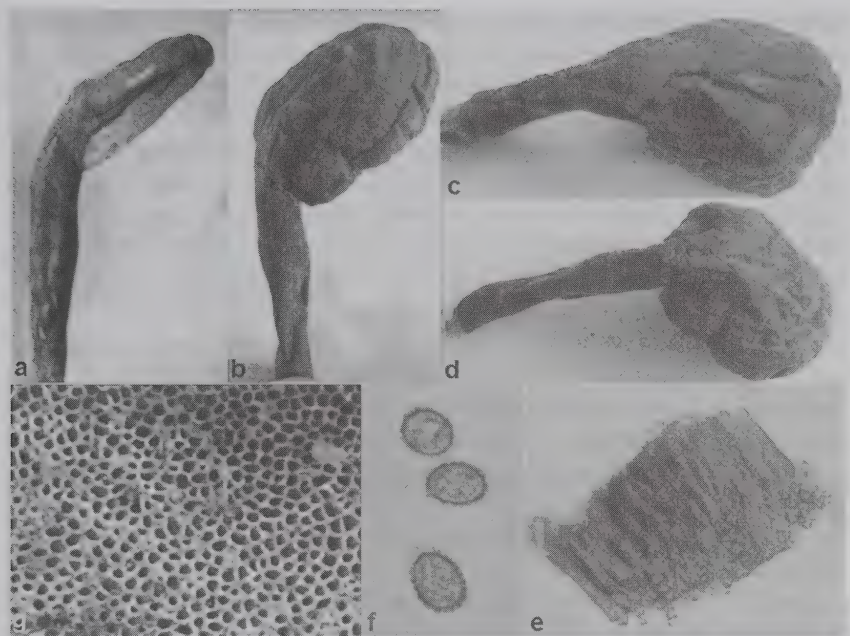


Figure 12- macro- and micromorphological characteristics of *Ganoderma tsugae*.
a-d, basidiocarp; e, cutis elements; f, basidiospores; g, pore surface

Discussion

Identifications of *Ganoderma* species were traditionally based on a combination of micro- and macromorphological studies and host relationship. More recently, cultural and mating type studies, together with molecular taxonomy added new insight into the taxonomy of this difficult group, resolving partly the taxonomical chaos of *Ganoderma*. Distributions of the *Ganoderma* species especially through Middle East and Asia in combination with their host relationship are still poorly known.

In the present work we investigated collections of *Ganoderma* species from Iran and introduced them based on micro- and macromorphology and host relationships and also provide a key for their identification. Seven *Ganoderma* species are reported from Iran, two of which belong to subgenus *Elfvingia* (P. Karst.) Imazeki (non-laccate species, *G. applanatum*, *G. adpersum*, and four species belong to subgenus *Ganoderma* (laccate species, *G. lucidum*, *G. resinaceum*, *G. tsugae*, *G. manoutchehrii*) and one species, *G. colossus*, that does not belong to above mentioned subgenera (This species was once placed in its own genus, *Tomophagus* Murrill. Although most authors consider *Tomophagus*

as a synonym of *Ganoderma*, recent data from molecular studies would support the recognition of the genus).

Most authors consider *Elfvigia* to be a subgenus of *Ganoderma* including non-laccate species, the laccate species being referred to as subgenus *Ganoderma*. The species belonging to subgenus *Ganoderma* have a hymenodermis or characodermis type cutis; many of them are stipitate or variably sessile to stipitate (see *G. resinaceum* for instance). Members of subgenus *Elfvigia* have a cutis and are mostly sessile. *Ganoderma applanatum* is the type species of *Elfvigia* and along with *G. adspersum*, form the core species in the *G. applanatum*-*adspersum* complex. *Ganoderma applanatum* possibly has a northern distribution (Ryvarden & Gilbertson 1993). *Ganoderma applanatum* and *G. adspersum* spread in temperate and humid areas of Iran that includes the southern margin of the Caspian Sea. In northern Iran with its temperate and humid climate the growth of some *Ganoderma* species is favored. In this area there are dense and temperate forests of *Alnus subcordata*, *Pterocarya fraxinifolia*, *Celtis caucasica*, *Quercus sessiliflora*, *Q. castaneifolia*, *Carpinus betulus*, *Fagus orientalis*, *Gleditschia caspica*, *Betula pendula*, and *Populus caspica*.

Ganoderma colossus was collected from southern subtropical areas of Iran growing on deciduous trees. This species has in contrast to other non-laccate species a hymenoderm.

G. manoutchehrii was described on the basis of a collection originating from Iran (Steyaert 1972). This species has not been collected during this study, although we specifically search for in the type locality.

Host specificity has been used to circumscribe *Ganoderma* taxa. In the northern temperate regions *G. valesiacum*, *G. carnosum* Pat., *G. tsugae* and *G. oregonense* have been distinguished from *G. lucidum* based on their host relationships, and all appear to be restricted to conifers. *Ganoderma tsugae* was originally described from North America on Conifer, and have been reported from East Asia (China and Japan) on *Picea*, *Pinus*, *Tsuga*, and *Abies*, more rarely on *Acer* and *Betula*.

Among the studied specimens IRAN 6722 F, IRAN 6721 F are Eurasian specimens of *G. lucidum*. They differ from Asian specimens in the amyloid reaction of cutis elements in Melzer's reagent. However, amyloid reaction of the cutis is not usually a stable character and may vary considerably with age and development, and consequently, has to be used with caution in the taxonomy of this genus (according to personal communications with Dr. Ryvarden). They differ also both in the size and ornamentation of their basidiospores. The Eurasian specimens have smaller basidiospores than Asian specimens ($4.8\text{--}5.7\text{--}6.7 \times 6.7\text{--}7.6\text{--}9.6 \mu\text{m}$) and the spines are more delicate, plentiful and smaller than in other specimens. It is important that in the first observation such spores

be very like *G. resinaceum* ones. With regard to such differences we can agree that such specimens belong to *G. lucidum* complex reported from Iran and that molecular studies can help us to more precise identification.

Acknowledgments

The authors would like to thank Dr. Henning Knudsen (Denmark), Dr. Cony Decock (Belgium), and Dr. Shaun Pennycook (New Zealand) for critically reviewing this paper and making valuable suggestions. Also special thanks are due to Prof. Leif Ryvarden (Norway) for guiding and confirming the identification of the specimens.

Literature

- Adaskaveg JE, Gilbertson RL. 1986. Cultural studies and genetics of sexuality of *Ganoderma lucidum* and *G. tsugae* in relation to the taxonomy of the *G. lucidum* complex. *Mycologia* 78: 694-705.
- Ames A. 1913. A consideration of structure in relation to genera of the *Polyporaceae*. *Annals of Mycology* 11: 211-253.
- Arefipour MR, Mousazadeh SA, Salary AN, Zokaei M. 2002. 15th Iranian plant protection congress, Kermanshah, Iran.
- Arefipour MR, Askary H, Sadeghi E, Musazadeh SA, Salary AN. 2004. Compare of diversity of Macromycetes in intact and non-intact forests. 16th Iranian plant protection congress, Tabriz, Iran.
- Atkinson GF. 1908. Observations on *Polyporus lucidus* Leys., and some of its allies from Europe and North America. *Botanical Gazette (Crawfordsville)* 46: 321-338.
- Bazzalo ME, Wright JE. 1982. Survey of the Argentine species of the *Ganoderma lucidum* complex. *Mycotaxon* 16: 293-325.
- Boudier E, Fischer E. 1894. Rapport sur les espèces de Champignons trouvées pendant l'assemblée a Geneve et les excursion faites en Valais. *Bulletin de la Société Mycologique de France* 41: 237-249.
- Boudier E. 1895. Description de quelques nouvelles espèces de Champignons recoltées dans les regions élevées des Alps du Valais, en aout 1894. *Bulletin de la Société Mycologique de France* 11: 27-30.
- Corner EJH. 1983. Ad Polyporaceas I. *Amauroderma* and *Ganoderma*. *Nova Hedwigia* 75: 1-182.
- Donk MA. 1948. Notes on Malesian Fungi I. *Bulletin du Jardin Botanique de Buitenzorg, 3e Série*, 17: 473-482.
- Donk MA. 1964. A conspectus of families of *Aphyllphorales*. *Persoonia* 3: 199-324.
- Flood J, Bridge PD, Holderness M. 2000. *Ganoderma* diseases of perennial crops. CABI Pub. USA.
- Gottlieb AM, Wright JE. 1999. Taxonomy of *Ganoderma* from Southern South America: subgenus *Ganoderma*. *Mycological Research* 103: 61-673.
- Habijan J, Berovic M, Wraber B, Hodzar D, Boh B. 2001. Immunostimulatory effects of fungal polysaccharides from *Ganoderma lucidum* submerged biomass cultivation. *Food Technology and Biotechnology* 39: 327-331.
- Haddow WR. 1931. Studies in *Ganoderma*. *Journal of the Arnold Arboretum* 12: 25-46.
- Hirofani M, Furuya T. 1986. Ganoderic acid derivatives, highly oxygenated lanostane-type triterpenoids, from *Ganoderma lucidum*. *Phytochemistry* 25: 1189-93.

- Hirotsu M, Ino C, Furuya T, Shiro M. 1986. Ganoderic acids T, S and R, new triterpenoids from the cultured mycelia of *Ganoderma lucidum*. Chemical and Pharmaceutical Bulletin 34: 2282-85.
- Hsueh RS. 1990. An identification system for cultures of *Ganoderma* species. PhD thesis, National Taiwan University, Taipei (in Chinese).
- Karsten PA. 1889. Bidrag till kännedom av Finlands Natur och Folk 48: 333.
- Karsten PA. 1881. Enumeratio Boletinearum et Polyporearum Fennicarum, Systemate novo dispositarum. Revue Mycologie (Toulouse) 3: 1-19.
- Komoda Y, Nakamura H, Ishihara S, Uchida M, Kohda H, Yamasaki K. 1985. Structure of new terpenoid constituents of *Ganoderma lucidum* (Fr.) Karst. (Polyporaceae). Chemical and Pharmaceutical Bulletin 48:29-35.
- Lee SY, Rhee HM. 1990. Cardiovascular effect of mycelium extract of *Ganoderma lucidum*: Inhibition of sympathetic outflow as a mechanism of its hypotensive action. Chemical and Pharmaceutical Bulletin 38: 1359-64.
- Lin CN, Fann YF, Chung MI. 1997. Steroids of formosan *Ganoderma lucidum*. Phytochemistry 46: 1143-46.
- Moncalvo JM. 2000. Systematic of *Ganoderma*. In: Flood J, Bridge PD, Holderness M. *Ganoderma* diseases of perennial crops. CABI Pub. USA.
- Moncalvo JM, Wang HF, Hsueh RS. 1995. Gene phylogeny of the *Ganoderma lucidum* complex based on ribosomal DNA sequences. Comparison with traditional taxonomic characters. Mycological Research 99: 1489-1499.
- Moradali MF, Abbasi M, Mostafavi H, Sharifi Tehrani A, Ghods S, Hedjaroude GA. 2004. Identification of *Ganoderma* Karst Species in Northern Forests of Iran. 16th Iranian plant protection congress, Tabriz, Iran.
- Murrill WA. 1902. The Polyporaceae of North America. I. The genus *Ganoderma*. Bulletin of the Torrey Botanical Club 29: 599-608.
- Murrill WA. 1908. Family 5. Polyporaceae. North American Flora 9: 73-132.
- Overholts LO. 1953. Polyporaceae of the United States, Alaska, and Canada. University of Michigan Press, Ann Arbor.
- Patouillard N. 1889. Le genre *Ganoderma*. Bulletin de la Société Mycologique de France 5: 64-80.
- Ryvarden L. 1991. Genera of Polypores. Nomenclature and taxonomy. Synopsis Fungorum 5. Fungiflora: Oslo, Norway.
- Saber M, Minassian V. 2000. Two new records of *Ganoderma* from Iran. 14th Iranian plant protection congress, Isfahan, Iran.
- Saber M, Esmaili Taheri A. 2004. A report on Macromycetes fungi from different parts of Iran. 16th Iranian plant protection congress, Tabriz, Iran.
- Saber M. 1973. Identification of Homobasidiomycetes collected in Iran. Iranian Journal of Plant Pathology 8: 20-45.
- Steyaert RL. 1961a. Genus *Ganoderma* (Polyporaceae). Taxa Nova. I. Bulletin Jardin Botanique de l'Etat Bruxelles 31: 69-83.
- Steyaert RL. 1961b. Note on the nomenclature of fungi and incidentally of *G. lucidum*. Taxon 10: 251-252.
- Steyaert RL. 1962. Genus *Ganoderma* (Polyporaceae). Taxa Nova. II. Bulletin Jardin Botanique de l'Etat Bruxelles 32: 89-104.
- Steyaert RL. 1967a. Considérations générales sur le genre *Ganoderma* et plus spécialement sur les espèces européennes. Bulletin de la Société Royale de Botanique Belgique 100: 189.
- Steyaert RL. 1967b. Les *Ganoderma* palmicoles. Bulletin Jardin Botanique National de Belgique 37: 465-492.

- Steyaert RL. 1972. Species of *Ganoderma* and related genera mainly of the Bogor and Lieden herbaria. *Persoonia* 7: 55-118.
- Steyaert RL. 1975. The concept and circumscription of *Ganoderma tornatum*. *Transactions of the British Mycological Society* 65: 451-467.
- Steyaert RL. 1977. Basidiospores of two *Ganoderma* species and others of two related genera under the scanning electron microscope. *Kew Bulletin* 31: 437-442.
- Steyaert RL. 1980. Study of some *Ganoderma* species. *Bulletin du Jardin Botanique National de Belgique* 50: 135-186.
- Su HJ, Fann YF, Chung MI, Won SJ, Lin CN. 2000. New lanostanoids of *Ganoderma tsugae*. *Journal of Natural Products* 63: 514-6.

***Orbilina vermiformis* sp. nov. and its anamorph**

ZEFEN YU¹, MIN QIAO¹, YING ZHANG¹, H.-O. BARAL², & KEQIN ZHANG^{1*}

*kqzhang111@yahoo.com.cn

¹Laboratory for Conservation and Utilization of Bio-resource
Yunnan University, Kunming, Yunnan 650091, PR China

²Blaihofstrasse 42, D-72074 Tübingen, German

Abstract—During our study of orbiliaceous fungi and their anamorphs, a specimen of *Orbilina* was collected and its anamorph culture was obtained. The morphological characteristics plus phylogenetic analyses based on nuclear rDNA sequences indicate that both the anamorph and teleomorph represent new novel distinct species. Both teleomorph and anamorph are described and illustrated. The teleomorph *Orbilina vermiformis* is similar to *O. crystallina*, but differing by its apothecia without solid, glassy processes at the margin, larger asci and ascospores, and the anamorph *Dactylella vermiformis* is characterized by branched conidiophores and 0-1-septate clavate conidia.

Key words—teleomorph-anamorph connection

Introduction

Xerointolerant species of the genus *Orbilina* Fr. are characterized by small, waxy, light-colored, semi-translucent apothecia, tiny asci and usually swollen paraphysis apices. This group of fungi is generally reported to occur on semi-moist decayed wood or bark and produces various anamorphs (Pfister 1997). The connection between *Orbiliaceae* and their anamorphs has been well established and many anamorph species have been reported recently (Mo et al. 2005a, b, Liu et al. 2005a, b, Yang & Liu 2005, Yu et al. 2006). However, anamorphs have been mainly isolated from species with subulate (Mo et al. 2005a, Webster et al. 1998, Pfister 1994, Pfister & Liftik 1995, Rubner 1996), subcylindrical (Liu et al. 2005a), globose and kidney-shaped (Pfister 1997) ascospores but not from species with helicoid ascospores. During our survey on the orbiliaceous fungi in China, an *Orbilina* species with helicoid ascospores was collected and its anamorph was obtained. The anamorph was placed within the genus *Dactylella* according to the system of Scholler et al. (1999). After detailed examination and phylogenetic analysis based on DNA sequences from

the internal transcribed spacer region (ITS) of the ribosomal RNA gene, we believe both teleomorph and anamorph were not described previously.

Materials and methods

The fresh holotype specimen of *Orbilbia vermiformis* was collected from XiaoHeiJiang Forest Park, Pu'er County, Yunnan Province, China, in September, 2005, by Min Qiao. The anamorph was isolated and observed as the way described by Yu et al. (2006). The measurement of each character is derived from 50 repeats. To induce the formation of nematode-trapping organs, about 100 nematodes (*Panagrellus redivivus* Goodey) into a 1 × 1 square centimeter slot at the margins of the colony where the agar was removed.

The total DNA of the fungus was isolated from fresh mycelium as described by Turner et al. (1997). A region of rDNA, containing the ITS regions 4, 5 and the 5.8S rRNA, was amplified by PCR using the primers described by White et al. (1990). The parameters for PCR amplifications were as follows: 1 min at 94°C, followed by 30 cycles of 94°C for 1 min, 50°C for 1 min, 74°C for 90 s, and a final extension period of 7 min at 74°C. The PCR products were purified with a commercial Kit (TaKaRa Biotechnology Co., Ltd.), and sequenced (Kindermann et al. 1998).

DNA sequences were aligned using the ClustalX 1.83 and the BioEdit programs. Parsimony analysis was run using PAUP* 4.0b10 (Swofford 2002), with the following settings: gaps treated as missing, all characters weighted equally, used heuristic searches with TBR (tree-bisection-reconnection) as the branch-swapping algorithm and bootstrap values generated using 1000 replicates.

Taxonomic description

Teleomorph:

Orbilbia vermiformis Baral, Z.F. Yu & K.Q. Zhang sp. nov.

FIGURE 1

MYCOBANK # MB510463

Apothecia 1.2–2.0 mm in diam., solitaria vel gregaria, margine glabra vel minute crenulata, superficialia, sessilia, alba vel pallide lutea. *Excipulum* ectale textura angulari, cellulis 10–35 µm diam, marginem versus sine processibus solidis. *Asci* 39.3–62.0 × 3.8–5.0 µm, 8-spori, cylindraceo-clavati, apice truncati, basi angustati plerumque furcati, apice truncati vel rotundati. *Ascospores* hyalinae, filiformes-subulatae, valde helicoideae, non-septatae, imbricate 2–4-seriatae, 8.8–11.5 × 1.0–1.5 µm, ad apicem cum vacuola refringente lacrimiforme, 1.3–1.8 × 0.8–1.0 µm. *Paraphyses* filiformes, apice non inflatae, usque 2.8–3.0 µm diam., hyalinae.

Etymology: *vermiformis*, referring to the worm-shaped ascospores.

Holotype: YMFT 1.01842, isolated from exposed rotten root of broad-leaved tree, XiaoHeiJiang Forest Park, Pu'er County, alt. 2100 m, Yunnan Province, PR China, Min Qiao. 3 Sep. 2005, a culture preserved in liquid nitrogen, permanent slide culture (YMFT 1.01842), Isotype: H.B. 8313.

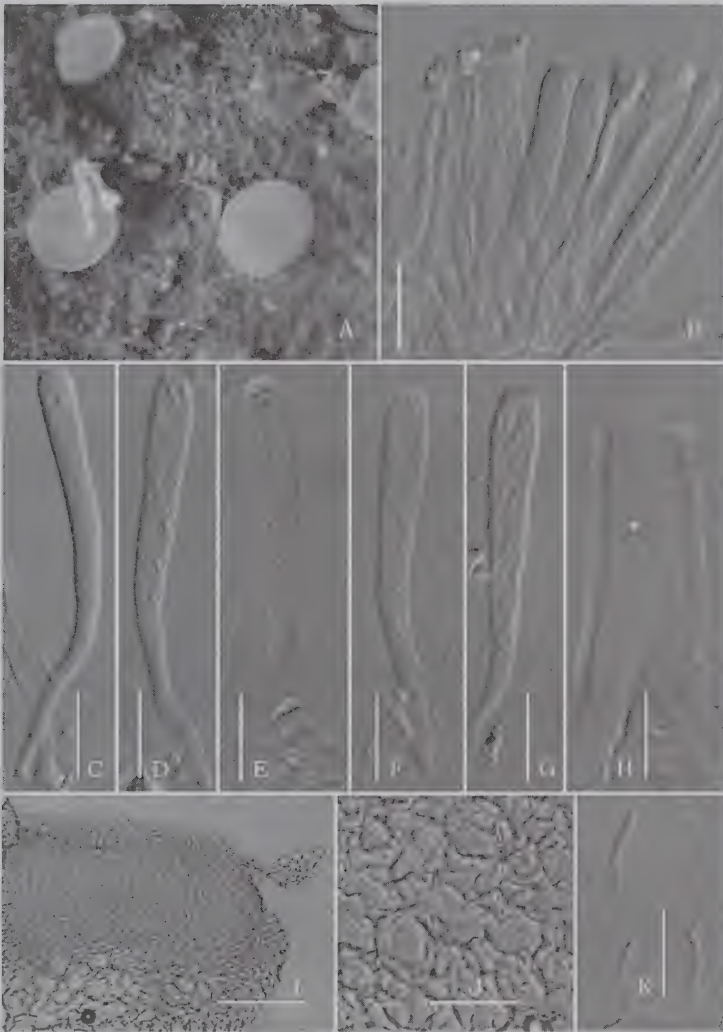


Fig 1. *Orbilia vermiformis*. Holotype A. Fresh apothecia. B. Cluster of asci and paraphyses. C-G. Dead asci with living spores. H. Dead paraphyses. I. Median section of an apothecium. J. Cells of ectal excipulum. K. Living ascospores. Scale bars: B-H, J-K = 10 μ m, I = 50 μ m.

Apothecia scattered to gregarious, sessile, superficial on rotten wood. Disc 1.2-2.0 mm in diam., white or pale yellow throughout, waxy, not translucent when fresh, margin even or minutely crenulate. Ectal excipulum 250 μ m thick in centre, composed of angular to prismatic cells from base to margin, hyaline, thin-walled, 25-45 $\times$ 10-35 μ m, marginal cortical cells 13-17 $\times$ 8-13 μ m, without glassy processes. Medullary excipulum 20 μ m thick, textura intricata-

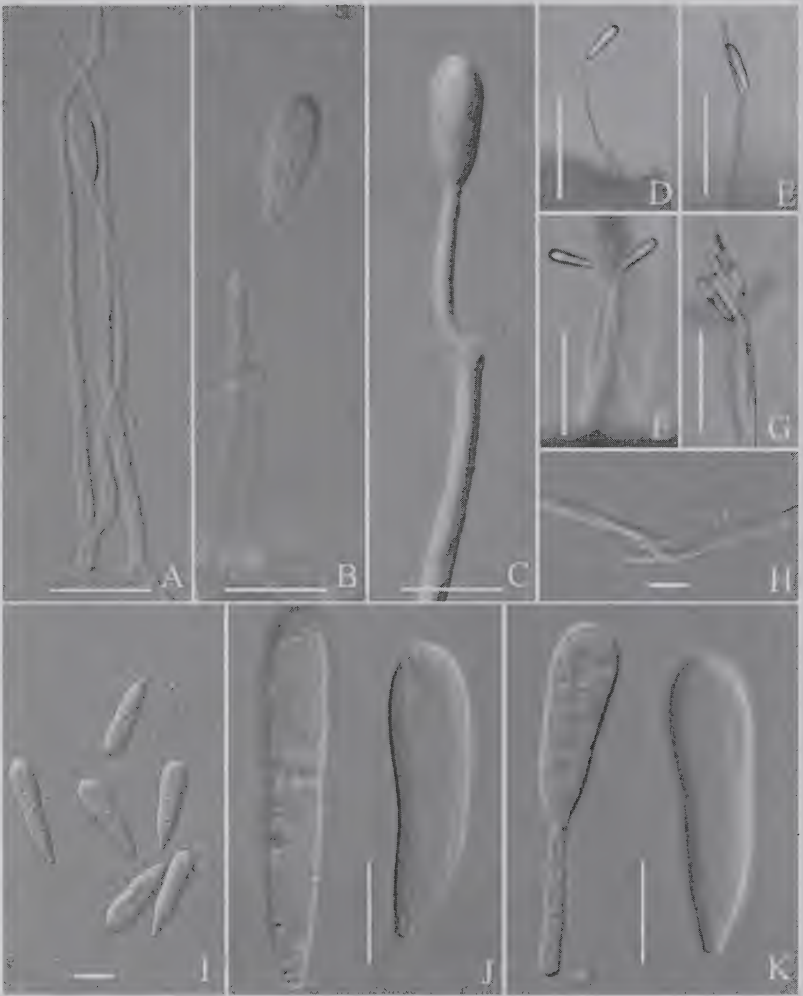


Fig. 2. *Dactylella vermiformis*. Holotype. A-G. Living conidiophores with conidia. H. Joint of two conidiophore bases. I-K. Living conidia.

Scale bars: A-C, J-K = 10 μm, D-G = 50 μm, H-I = 10 μm.

angularis. Asci cylindric-clavate, rounded or strongly truncate with a distinct indentation (depending on direction of view) at the thin-walled apex, tapered and often forked at the base, 8-spored, $39.3-62.0 \times 3.8-5.0 \mu\text{m}$ (living state), $45 \times 3.3-3.7 \mu\text{m}$ (in KOH). Ascospores hyaline, non-septate, filiform, helicoid or sigmoid, $8.8-11.5 \times 1.0-1.5 \mu\text{m}$ (living state) and $10-10.7 \times 0.9-1.1 \mu\text{m}$ (in KOH), broadest above and slightly tapered to the rounded upper end, gradually tapered to a fine point at the base, lower spores in ascus inversely oriented, bearing a refractive tear-shaped spore body (SB) at the apex (broader end), 1.3-

1.8 × 0.8-1.0 µm, attachment of SBs to the apical wall of the ascospores partly visible. Paraphyses filiform, apex not or only very slightly enlarged to 2.8-3.0 µm, usually covered at the apex by a thin rough exudate, containing globose SCBs (cytoplasmic bodies).

Anamorph:

Dactylella vermiformis Z.F. Yu, Ying Zhang & K.Q. Zhang sp. nov.

FIGURE 2

MYCOBANK # MB510462

Coloniae in agar CMA, post 10 dies 25°C 40 mm diam. Mycelium sparsum, hyphis septatis, 3-4 µm latis. Conidiophora erecta, simplices vel ramosae, 70-150 µm longa, 3 µm lata ad basim, 1.8-2 µm lata ad apicem. Conidia hyalina, clavata, 20-36.8 × 5.8-8.1 µm, 0-1 septata.

Etymology: species epithet refers to the teleomorph species.

Holotype: YMF 1.01842, permanent slide, XiaoHeiJiang Park, Pu'er County, Yunnan, P. R. China, alt. 2100 m, Min Qiao, Sep. 2005.

Colonies white, growing slowly on PDA, reaching 44 mm at 21°C after 10 days, 63 mm at 25°C, 61 mm at 28°C, no growth at 35°C, producing black pigment in the back of colonies. Colonies white, aerial mycelium sparse on CMA, 2.5-4 µm wide, reaching 30 mm at 22°C, 40 mm at 25°C, 45 mm at 28°C after 10 days, no growth at 35°C. Vegetative hyphae hyaline, branched and septate, 3-4 µm wide. Primary conidiophores septate, erect, simple or branched, 3 µm wide at the base and 1.8-2 µm wide above, 70-150 µm in length, single conidiophores with a single apical spore, most conidiophores growing in flexing knee with a spore at the flexing place, and another spore at the apex. Conidiophores often form loose bundles because of the joining of conidiophore bases. Conidia colorless, clavate, rounded at the distal end, constricted into bottleneck shape at the proximal end, straight, sometimes slightly curved, with (0-)1 septum (median or nearer to distal end), occasionally constricted at septum, 20.0-36.8 (25.3) × 5.8-8.1 (6.7) µm (living state). No trapping structures on WA were observed when nematodes were added.

Phylogenetic analysis

Maximum parsimony analysis of the ITS sequences (FIG. 3) yielded single tree based on 260 parsimony informative characters (constant characters are 221 and uninformative characters are 89). The MP tree had 1044 steps in length with a consistency index (CI) of 0.614 and a retention index (RI) of 0.6147. In our analysis, *Hyalorbilia brevistipitata* (a member of the family *Orbiliaceae*) was used as an outgroup. The ITS phylogenetic tree indicated that taxa forming adhesive knobs, forming constricting rings and forming networks clustered into different clades respectively, but four species of *Dactylella* located within different clade. *D. vermiformis* showed close affinities to species producing constricting rings and species producing adhesive knobs. Unfortunately, in our

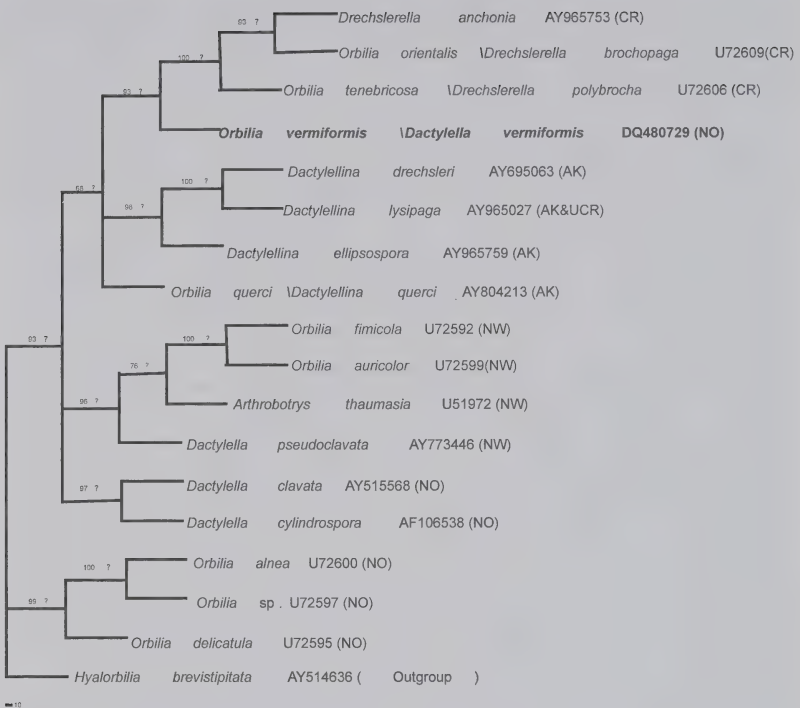


Fig. 3 Most parsimonious phylogenetic tree generated from a heuristic search based on the alignment of the ITS region sequences of some nematode-trapping fungi. Numbers above lines represent bootstrap values from 1000 replicates on all parsimony-informative characters, with only bootstrap values >50% shown. Except for the sequence of *O. vermiformis*, other sequences were obtained from the GenBank (accession numbers shown following each taxon name). The abbreviation in the parenthesis for each taxon refers to nematode-trapping device (or no device): AK, adhesive knobs; CR, constricting rings; NW, networks; UCR, non-constricting ring; NO, no-trapping advice.

molecular analyses no ITS sequence of species morphologically similar to *D. vermiformis* is available from GenBank, except *Dactylella pseudoclavata*, and these two species are phylogenetically distant.

Discussion

Morphologically, *D. vermiformis* is similar to *Dactylella arrhenopa* (Drechsler) K.Q. Zhang et al., *Dactylella polyclona* (Drechsler) K.Q. Zhang et al. and *Dactylella pseudoclavata* Z.Q. Miao & X.Z. Liu in producing clavate conidia with one septum (Zhang et al. 1995, Miao et al. 2003). However, conidia of *D. vermiformis* were larger with broader distal end than that of *D. arrhenopa*

and *D. polyclona*. Compared to *Dactylella pseudoclavata*, *D. vermiformis* has shorter conidia without nematode-trapping devices whereas *D. pseudoclavata* produces three-dimensional trapping networks (Table 1).

Table 1. Morphological comparison of *D. vermiformis* and similar species.

<i>Dactylella</i> species	Size of conidia (µm)	Trapping device	Number of conidial septa
<i>D. pseudoclavata</i>	30 – 45 × 8 – 11	three-dimensional networks	0-1
<i>D. vermiformis</i>	20.0 – 36 × 5.8 – 8.1	not observed	0-1
<i>D. polyclona</i>	12.7 – 21 × 2.3 – 2.8	not observed	1
<i>D. arrhenopa</i>	17 – 25 × 2.6 – 3.7	not observed	1

Orbilia vermiformis, the teleomorph of *Dactylella vermiformis*, is also distinctly different from other described species in the genus *Orbilia*. *O. vermiformis* is characterized by filiform, helicoid ascospores. Although similar ascospores exist in *Orbilia crystallina* (Quél.) Baral, those of *O. vermiformis* are broader and longer than that of *O. crystallina*. Other characteristics such as marginal cortical cells of *O. crystallina* being elongated and terminated by glassy and solid processes were not found in *O. vermiformis*, while the asci and paraphyses of *O. vermiformis* are distinctly larger than those of *O. crystallina*. In our present specimen, the apothecia of *O. vermiformis* were not translucent which is rather unusual, especially in xerointolerant species of *Orbilia*. However, in an American collection referable to *O. vermiformis* (see below) the apothecia were medium translucent.

A collection from Central America (Martinique, Le St. Esprit, Le Bois La Charles, bark of broad-leaved tree, C. Lechat, H.B. 8031) fits quite well with the type of *O. vermiformis*, except the narrower marginal cortical cells (9-15 × 5-7 µm). Also the presumed anamorph which was found on the natural substrate, resembles that of the type of *D. vermiformis* but the 1-septate conidia were found to be smaller (14.5-20.5 × 4.2-6.5 µm, in KOH). For the time being the specimen is considered to belong in the scope of *O. vermiformis*.

It was strange that *D. vermiformis* did not produce any nematode-trapping devices but was grouped with constricting ring forming species with 93% bootstrap support in phylogenetic tree. The possible reasons could be that the fungus lost its ability to form trapping devices or the fungus could capture other microscopic animals such as rotifers and rhizopods. The predatory ability of this fungus needs to be further investigated.

Acknowledgements

We are very grateful to Prof. X.Z. Liu and Prof. S.D. Li for critically reviewing the manuscript and providing precious suggestions on this paper. This work was jointly supported by Ministry of Science and Technology of PR China (2003CB415102) and the Department of Science and Technology of Yunnan Province (approved no. 2005NG05).

Literature Cited

- Kindermann J, EL-Ayouti Y, Samuels GJ, Kubicek CP. 1998. Phylogeny of the genus *Trichoderma* based on sequence analysis of the internal transcribed spacer region 1 of the rDNA clade. *Fungal Genet. Biol.* 24: 298-309.
- Liu B, Liu XZ, Zhuang WY. 2005a. *Orbilbia querci* sp. nov. and its knob-forming nematophagous anamorph. *FEMS Microbiol. Lett.* 245: 99-105.
- Liu B, Liu XZ, Zhuang WY. 2005b. A new species of *Hyalorbilbia* and its anamorph from China. *Nova Hedwigia* 81: 145-155.
- Miao ZQ, Liu XZ, Li SD, He MX. 2003. *Dactylella pseudoclavata* sp. nov., a new nematode-trapping fungus. *Can. J. Bot.* 81: 1-5.
- Mo MH, Huang XW, Zhou W, Huang Y, Hao YE, Zhang KQ. 2005a. *Arthrobotrys yunnanensis* sp. nov., the fourth anamorph of *Orbilbia auricolor*. *Fungal Diversity* 18: 107-115.
- Mo MH, Zhou W, Huang Y, Yu ZF, Zhang KQ. 2005b. A new species of *Dactylella* and its teleomorph. *Mycotaxon* 91: 185-192.
- Pfister DH. 1994. *Orbilbia fimicola*, a nematophagous discomycetes and its *Arthrobotrys* anamorph. *Mycologia* 86: 451-453.
- Pfister DH, Liftik ME. 1995. Two *Arthrobotrys* anamorphs from *Orbilbia auricolor*. *Mycologia* 87: 684-688.
- Pfister DH. 1997. Castor, Pollux and life histories of fungi. *Mycologia* 89: 1-23.
- Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. *Stud. Mycol.* 39: 1-134.
- Swofford DL. 2002. PAUP*: *Phylogenetic Analysis Using Parsimony (*and other methods)*. Version 4.0b10. Sinauer Associates, Sunderland, Massachusetts.
- Scholler M, Hagedorn G, Rubner A. 1999. A reevaluation of predatory orbiliaceous fungi. II. A new generic concept. *Sydowia* 51: 89-113.
- Turner D, Kovacs W, Kuhls K, Lieckfeldt E, Peter B, ArisamAtac I, Strauss J, Samuels G. J, Borner T, Kubicek CP. 1997. Biogeography and phenotypic variation in *Trichoderma* sect. *Longibrachiatum* and associated *Hypocrea* species. *Mycol. Res.* 101: 449-459.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. 315-322, in MA Innis et al. (eds.), *PCR Protocols: a guide to methods and applications*. San Deigo, Academic Press.
- Webster J, Henrici A, Spooner B. 1998. *Orbilbia fimicoloides* sp. nov., the teleomorph of *Dactylella* cf. *oxyspora*. *Mycol. Res.* 102: 99-102.
- Yang Y, Liu XZ. 2005. *Dactylella coccinella* sp. nov., an anamorphic species. *Mycotaxon* 91: 127-132.
- Yu ZF, Zhang Y, Qiao M, Baral HO, Weber E, Zhang KQ. 2006. *Drechslerella brochopaga*, the anamorph of *Orbilbia (Hyalinia) orientalis*. *Mycotaxon* 96:163-168.
- Zhang KQ, Liu XZ, Cao L. 1995. A review of *Dactylella* and a new species. *Mycosystema* 7: 111-118.

Studies on *Lactarius*: Two new records from Costa Rica and additional information from MexicoLETICIA MONTOYA^{1*}, VICTOR M. BANDALA¹ & MILAGRO MATA²

leticia.montoya@inecol.edu.mx

¹ Dept. Biodiversidad y Sistemática, Instituto de Ecología
A.C., P.O. Box 63, Xalapa, Veracruz 91000, Mexico² Instituto Nacional de Biodiversidad
P.O. Box 22-3100, Santo Domingo de Heredia, Costa Rica

Abstract— *Lactarius luteolus* and *L. verae-crucis* are recorded from Costa Rica for the first time. New collections from Veracruz and Guerrero expand their known distribution ranges. Studies on fresh basidiomes of *L. luteolus* recorded throughout 2002–2005 from a monitored plot in a protected mesophytic forest in Veracruz, Mexico, revealed additional data on its morphology, phenology, and ecological association with *Carpinus caroliniana*. Descriptions, coupled with illustrations of macro- and micromorphological features and discussions of both taxa, are presented based on Costa Rican and Mexican specimens.

Key words—ectomycorrhizal fungi, neotropics, *Russulaceae*, taxonomy

Introduction

Knowledge about the distribution of *Lactarius* in The American Continent is gradually being improved with data from the Neotropics (Singer et al. 1983, Montoya et al. 1990, Mueller & Halling 1995, Montoya 2000). The distribution of ectotrophic trees with temperate affinities such as *Pinaceae*, *Fagaceae* and *Betulaceae* in Mexican forests (Rzedowski 1978, Styles 1993) explains the high diversity of ectomycorrhizal macrofungi such as *Lactarius*. In Costa Rica, both *Alnus* (Halling 2001) and *Quercus* (Singer et al. 1983, Halling 2001, Halling & Mueller 2002, Montoya et al. 2003, Montoya & Bandala 2005) represent important associated phanerogams which allow for the near continuous distribution of some *Lactarius* taxa from North America into Central America.

Lactarius luteolus has been documented from several regions of the U.S.A. and Canada, in deciduous and mixed woods (Peck 1896, Burlingham 1908,

* Corresponding author: L Montoya — leticia.montoya@inecol.edu.mx

Murrill 1938, Hesler & Smith 1979, Smith & Smith 1985, Phillips 1991, Bessette et al. 1997). In Mexico the species has been recorded in the West Coast, in a mesophytic forest (Montoya & Bandala 2005). In this paper we provide data to document that it also occurs in Eastern Mexico, in association with *Carpinus*, and in Costa Rica with *Quercus oleoides* Schltdl. & Cham.

The lowlands of Mexico house *Lactarius* species known from tropical regions, such as *Lactarius verae-crucis*, which is one of the under-collected species of the genus. It was first described from a tropical rain forest in southern Veracruz (Mexico) (Singer 1973) and then from the Dominican Republic (Singer 1975). In Mexico the species is also known from Chiapas and Jalisco (Montoya et al. 1996) and Guerrero (this paper). Here we document that *L. verae-crucis* occurs also in northern Costa Rica, in subtropical humid forest and in pre-montane forest from Guanacaste and Alajuela.

Materials and methods

Macromorphological characters were observed on fresh basidiomes collected in Mexico and Costa Rica. Colour codes in descriptions refer to Kornerup & Wanscher (1967), Smithe (1975) (in italics) and Munsell (1994) (in bold). One of the species treated here, *Lactarius luteolus*, was studied in a monitored plot within the cloud forest adjacent to the Instituto de Ecología A.C. at Xalapa, Veracruz (Santuario del Bosque de Niebla) which was visited weekly during 2002-2005. Measurements and colours of the micromorphological structures were recorded in 3% KOH, except for the basidiospores, which were studied in Melzer's reagent. The methods used to estimate spore ranges and SEM analyses are those used by Montoya & Bandala (2003). In the basidiospore descriptions, 0 corresponds to the range of means of basidiospore length and width, and Q to the range of the mean of Q (length/width ratio) of *n* collections. Line drawings were made with the aid of a drawing tube. The acronyms for the Herbaria follow Holmgren et al. (1990).

Results

Lactarius luteolus Peck, Bull. Torr. Bot. Club 23: 412, 1896.

Figures 1-3

= *L. foetidus* Peck, Bull. N.Y. St. Mus. 54: 949, 1902.

= *L. praeserifluus* Murrill, Mycologia 30: 361, 1938.

= *L. echinatus* Thiers, Mycologia 49: 716, 1957.

Pileus 15–75 mm diam, plano-convex, plane to slightly depressed centrally, at times with a short eccentric lobe, without umbo, azonate, yellowish, yellowish with a pale orange tint to grayish-orange (5A4, 3B4-5); primordia yellowish-white to pale yellow-ochre with pale orange tinges (4-5A2-4; 7.5YR 8/6, 10YR 8/6); subtomentose to tomentose or velutinous, dry, compact and rigid; margin



Fig. 1. *Lactarius luteolus* basidiomes
(a. Montoya 4400, b. Montoya 4014). Bar = 1 cm.

rugose, edge entire, undulate, decurved when young, smooth to faintly rugose. *Lamellae* narrow, 1–3 mm wide, crowded or close if lamellulae are excluded, adnate to faintly sinuate, with lamellulae of at least five sizes, yellowish-white to yellowish (4A2–4, 3A2; 2.5Y 8/3), stained brown, margin entire. *Stipe* 8–55 x 4–22 mm, cylindrical, equal or at times attenuated towards the base, central or frequently excentric, at times fasciculate, rigid, tomentose, compact, dry, at times rugose, concolorous to darker than pileus surface, yellowish-white to pale orange or grayish orange (4A2, 5A3, 5B5–C5; 7.5YR 7/6–8/4, 8/6), primordia yellowish-white to pinkish-orange (4A2, 5A2; 7.5YR 8/4); reddish-brown after bruising. *Latex* watery-white to white, stained brown after some minutes of exposure and stains white paper brown, abundant, taste mild, at first very fluid, latter sticky and more dense, negative to KOH. *Context* cream to beige, staining brown when exposed, compact. *Odor* of fish. *Taste* mild.

Basidiospores 6.5–8.5 (–9) x 5.6–6.5 (–7) μm , $Q = 7.3\text{--}7.9 \times 6\text{--}6.2 \mu\text{m}$, $Q = 1.2\text{--}1.3$, broadly ellipsoid, verrucose, ornamentation 0.5–1 μm high, composed of isolated warts, suprahilar plage at times with a faint or coarse amyloid dot. *Basidia* 50–67 x 7–8 μm , clavate, sinuous, tetrasporic, with granular refringent contents. *Pleurocystidia* septate, terminal segments 14–45 x 4–8 μm , subcylindric, capitate, other segments 20–28 x 5–8 μm , hyaline, at times with dense yellow-brown contents, thin walled. *Cheilocystidia* 16–76 x 3–10 μm , subcylindric, clavate, capitate, apex up to 13–17 μm diam, thin walled or at times 1.2–1.5 μm thick, septate. *Pseudocystidia* 3–8 μm diam, attenuated towards the apex, contorted, originated from the trama. *Pileipellis* composed of a trichodermis above a pseudoparenchymatous layer; suprapellis with subcylindric, septate elements; terminal cells 9–76 x 3.4–8 μm , thin or thick-walled, frequently capitate; subpellis composed of sphaerocytes 10–40 μm diam, wall up to 1 μm thick. *Context* hyphae 3–12 μm diam, laticifers 5–20 μm diam, abundant, sphaerocytes 15–31 μm diam. *Hymenophoral trama* hyphae 3–11 μm diam, laticifers 6–14 μm diam, abundant, sphaerocytes 10–20 μm diam; subhymenial layer composed of subcylindrical septate cells, 6–20 x 5–10 μm .

Habitat: Gregarious in small troops. In Costa Rica in tropical humid forest in transition to pre-montane, at 800–900 m alt., reaching the tropical dry forest in ecotone with humid forest at 300 m alt., both sites with *Quercus oleoides*. In Mexico in cloud forest, growing near *Carpinus caroliniana* Walter and *Quercus* spp., at 1300 m alt.

Material examined: COSTA RICA. Guanacaste. Area de Conservación Guanacaste, Parque Nacional Rincón de la Vieja, Sector Las Pailas, Sendero a Las Cataratas, 20 July 1996, C. Cano 338 (INB 0001543824); Parque Nacional Santa Rosa, Bosque San Emilio, 15 June 2003, M. Mata 1281 (INB 0003721250). MEXICO. Veracruz, Mpio. Xalapa, Instituto de Ecología, Santuario del Bosque de Niebla, 4 July 2003, Montoya 4014;

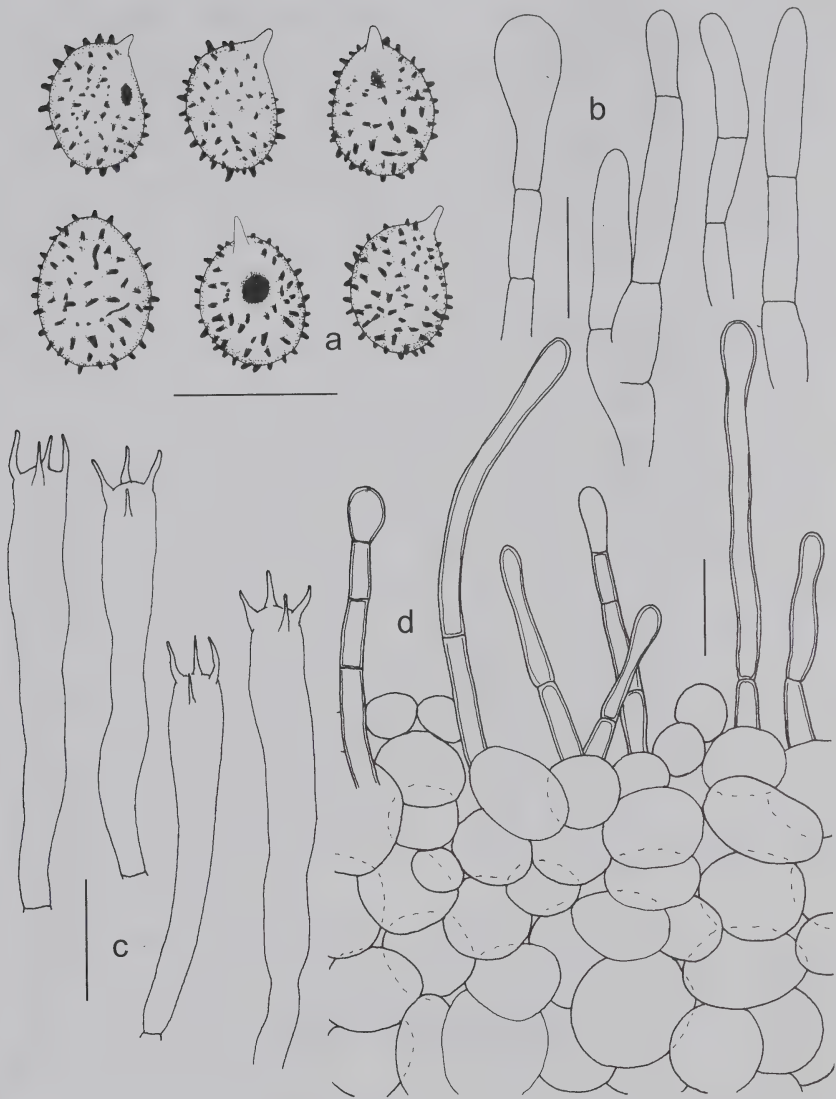


Fig. 2. *Lactarius luteolus* (Mata 1281).

A. Basidiospores, b. Pleurocystidia, c. Basidia, d. Pileipellis.

Bars: a = 10 μ m, b-d = 20 μ m.

8 July 2003, *Montoya* 4031; 14 July 2003, *Montoya*, 4040; 16 July 2003, *Montoya* 4047; 26 September 2003, *Montoya* 4058; 13 November 2003, *Montoya* 4067; 3 August 2005, *Bandala* 3993; 25 August 2005, *Montoya* 4400; 19 October 2005 *Montoya* 4411 (all at XAL).

Other material examined: U.S.A. Massachussetts, East Milton, August, *H. Webster* s/n (NYS *Lactarius luteolus* holotype).

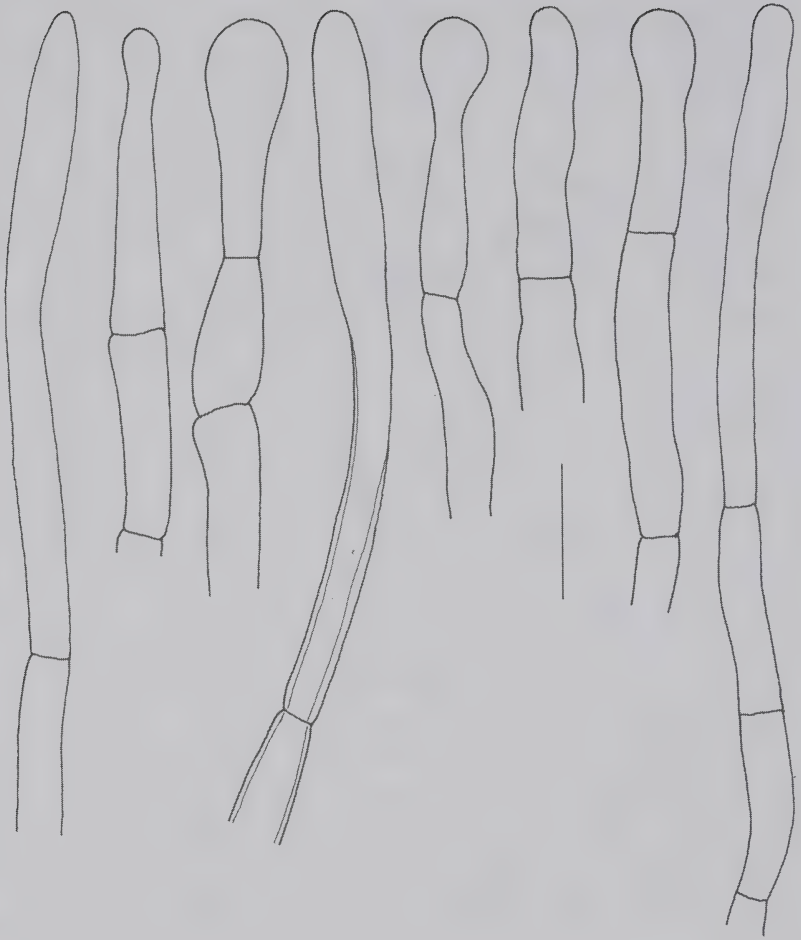


Fig. 3. *Lactarius luteolus* (Mata 1281).
Cheilocystidia. Bar = 20 μ m.

Notes: The material upon which Singer (1990) based his report of *Lactarius echinatus* (a synonym of *L. luteolus*) from NE Mexico belongs to another taxon (Montoya & Bandala 2005). After the study of a specimen collected by Ruth McVaugh (1985) in Jalisco, housed at MICH, Montoya & Bandala (2005) formally recorded *L. luteolus* from Mexico. The macro- and micromorphological features described above are based on new fresh collections gathered in Mexico

and Costa Rica, which complement the micromorphological information recovered from the specimen of R. McVaugh 985 [for SEM study see Montoya & Bandala (2005)]. The ecological information recorded during weekly visits to a plot dominated by *Carpinus caroliniana* in Veracruz showed that the species presented a summer-autumn phenology in the area and that it did not fructify yearly. No basidiomes were found in 2002 or 2004. While *Lactarius luteolus* was found under *Carpinus caroliniana* in Veracruz, it was found associated with *Quercus oleoides* in Costa Rica. and with *Quercus* spp. in U.S.A. (Murrill 1938).

Basidiome colour for *L. luteolus* observed during different stages of development in the examined collections from both countries ranges from yellowish to pale yellow with pale orange to pale yellowish-ochre tinges. The studied samples are more or less similar in colour to those shown by Phillips (1991). Illustrations of *L. luteolus* in different contributions (Marchand 1980, Courtecuisse & Duhem 1994, Basso 1999, web page of "Micolist" Pérez-De-Gregorio i Capella <http://www.grn.es/amjc/activi/linars.htm>, Bessette et al. 1997), in general depict whitish basidiomes or whitish with brownish stains but not basidiomes with yellowish colours. We interpret the colour shown by Mexican and Costa Rican specimens as coinciding with the concept of buff colour used in the protologue (Peck 1896), the pale yellow or buff colour described by Peck (1902) (as *L. foetidus*), the pale yellowish by Murrill (1938) (under *L. praeserifluus*) and the buff or yellow buff shades mentioned by Peck (1902a). The comment by Peck (1896) that *Lactarius luteolus* is related to *L. volemus* and *L. hygrophoroides* but with a paler buff colour, as well as the common name "yellowish *Lactarius*" applied by Peck (1902a) can inform us also on *L. luteolus* colour variation. The basidiospore shape and verrucose ornamentation pattern, the structure of pileipellis and hymenial elements of the studied specimens are similar to the holotype.

Lactarius capitatus K. Das et al. described from Himalaya is a close allied taxon which is distinguished from *L. luteolus* by the reddish-orange pileus, orange-yellow lamellae and context, latex turning to pinkish, dark reddish-brown or finally brown, and subglobose basidiospore shape ($Q = 1-1.1$) (Das et al. 2004).

Lactarius verae-crucis Singer, Beih. Sydowia 7: 104 (1973)

Figures 4-6

Pileus 25–80 mm diam., centrally depressed, plane, often uplifted to infundibuliform, subtomentose, rugose, bright yellow-orange colour (*16 chrome orange*, *17 Spectrum Orange*) to bright yellow-orange or egg yellow, margin faintly sulcate, edge entire. **Lamellae**, distant to subdistant, subdecurrent, narrow, up to 4 mm wide, with anastomosing veins between the lamellae,

thick, white-cream (153 *Trogon Yellow*, 92 *Pale Horn*) to yellowish with orange tinges, subdecurrent, edge even, lamellulae present. **Stipe** 30–55 x 5–9 mm, subcylindric, subvelvety, yellow-orange (16 *Chrome Orange*, 17 *Spectrum Orange*), concolorous with pileus or paler, subcylindric, slightly attenuated towards the base. **Latex** white, staining the lamellae pinkish-brown when drying. KOH stains the pileus and stipe faintly yellow-green. **Context** whitish. **Odor** of fish when dried. **Taste** mild. **Spore print** white-cream.

Basidiospores (6.4–) 8–8.8 (–10.4) x 5.6–7.5 (–8) μm ; $Q = 7\text{--}8.8 \times 6.1\text{--}7.2$ μm ; $Q = 1.13\text{--}1.23$; subglobose to broadly ellipsoid, subreticulate or with an incomplete reticulum, ornamentation up to 0.5 μm high; under SEM seen to have irregular verrucae, at times nodulose, isolated or with a pronounced base and then joined. **Basidia** 64–120 x 6.4–10.4 μm , tetrasporic, cylindrical, attenuated towards the base, where it appears sinuous or contorted, thin walled, born from subhymenium or deeper. **Pleurocystidia** 40–120 x 4–6 μm , subcylindrical, subfusiform, sinuous to contorted, at times (mostly when young) projected above the hymenial level, septate, thin-walled, wall at times faintly thick; terminal segment 28–41.6 x 3–7.2 μm . **Pseudocystidia** 2.4–4 μm diam, subcylindric. **Cheilocystidia** (25.6–) 32–100 x 3.2–5.6 μm , subcylindrical, subfusiform, contorted, or bifurcate, septate, at times (mostly when young) faintly thick-walled, 0.8 μm thick, abundant, projected; terminal segment 26–49 x 3.2–5 μm , rounded, equal or attenuated at apex. **Pileipellis** a trichodermis above a pseudoparenchymatous layer; suprapellis consisting of erect, filamentous, subcylindric, subclaviform, subfusiform, sinuous, simple or branched elements, thin or slightly thick-walled, wall up to 0.8 (–1.6) μm thick, born from subisodiametric or irregular cells or some from hyphal elements originating from the subpellis or even from the context; terminal cells 13–56 x (2.4–) 4–4.8 (–5.6) μm , other elements 20–35 x 3–5 μm ; subpellis composed of subisodiametric cells, 8–35 μm diam., thin or thick-walled, 0.8–1.6 μm thick or with thick, yellowish-green patches (up to 2 μm thick), irregularly disposed. **Context** hypae 4–12 μm diam, laticifers 5–12 μm diam, sphaerocytes 8–36 μm diam. **Hymenophoral trama** composed of hyphae 3.2–9.2 μm diam, laticifers 4–10.7 μm diam and abundant sphaerocytes 8–25 μm diam.

Habitat: Solitary, terricolous. In Costa Rica, in a subtropical humid forest at 600–700 m alt. and in pre-montane humid forest at 1250–1300 m alt. Both sites with Sapotaceae and very scarce and scattered *Quercus*. In Mexico, in tropical rain forest at 180 m alt. and tropical semi-evergreen forest at 130 m alt.

Material examined: COSTA RICA. Guanacaste, Area de Conservación Arenal, Zona Protectora Miravalles, Sector Finca Río Naranjo, 23 May 1999, I. López 401 (INB 0001545919). Alajuela, Area de Conservación Arenal, Bijagua, Albergue Heliconias, Sendero Heliconias, 22 May 1999, I. López 383 (INB 0001545909). MÉXICO, Guerrero, Mpio. Tierra Colorada, Xolapa, 4 July 1981, Capello 47 (FCME).

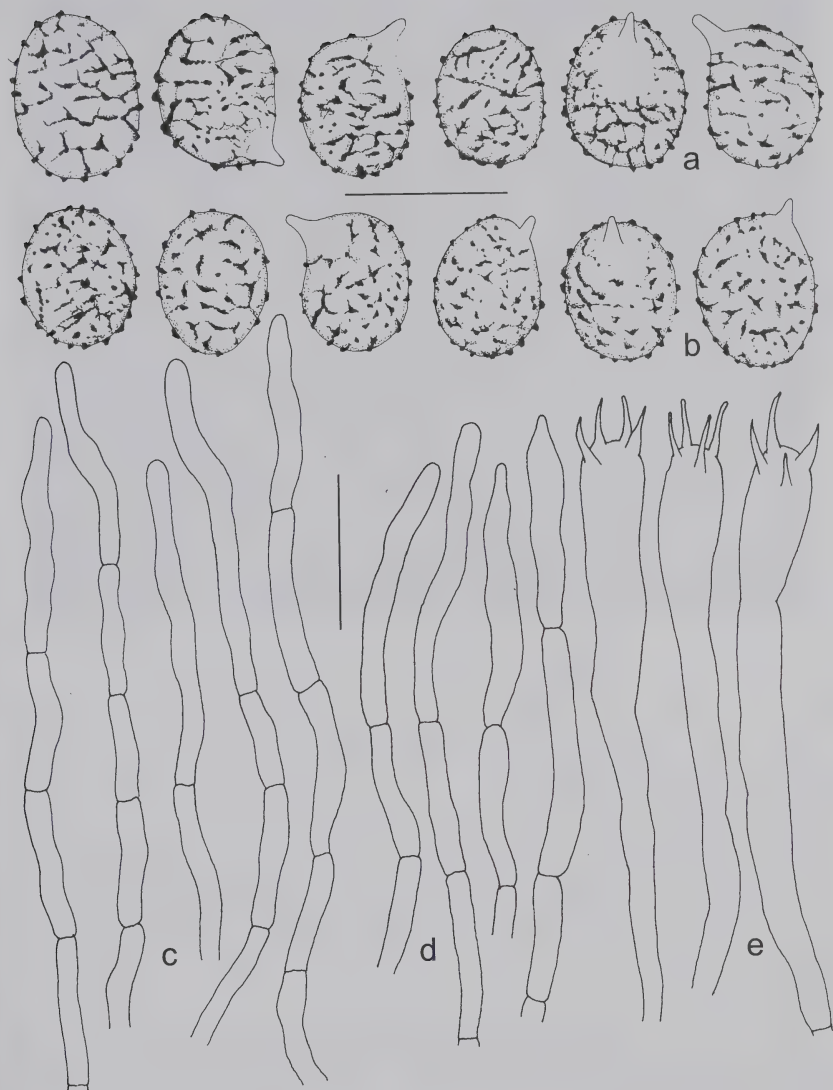


Fig. 4. *Lactarius verae-crucis* (López 397).

A-b. Basidiospores, c. Pleurocystidia, d. Cheilocystidia, e. Basidia.

Bars: a-b = 10 μ m, c-e = 20 μ m.

Other material examined: MEXICO, Estación Biológica de Los Tuxtlas, 19 July 1969, Singer M-8025 (ENCB *Lactarius verae-crucis* isotype). BURUNDI, Nyamirambo, near Rumoge, March 1994, Verbeken 94.463 (BR, *Lactarius luteopus*, holotype).

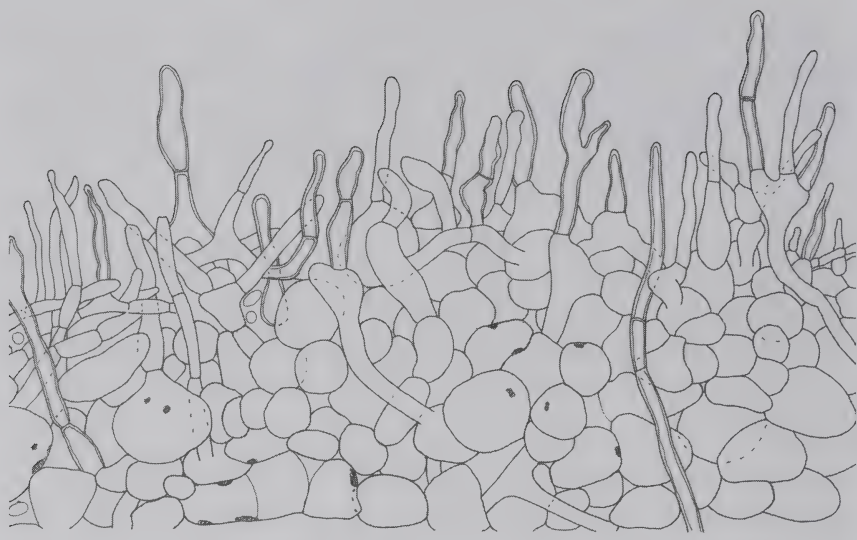
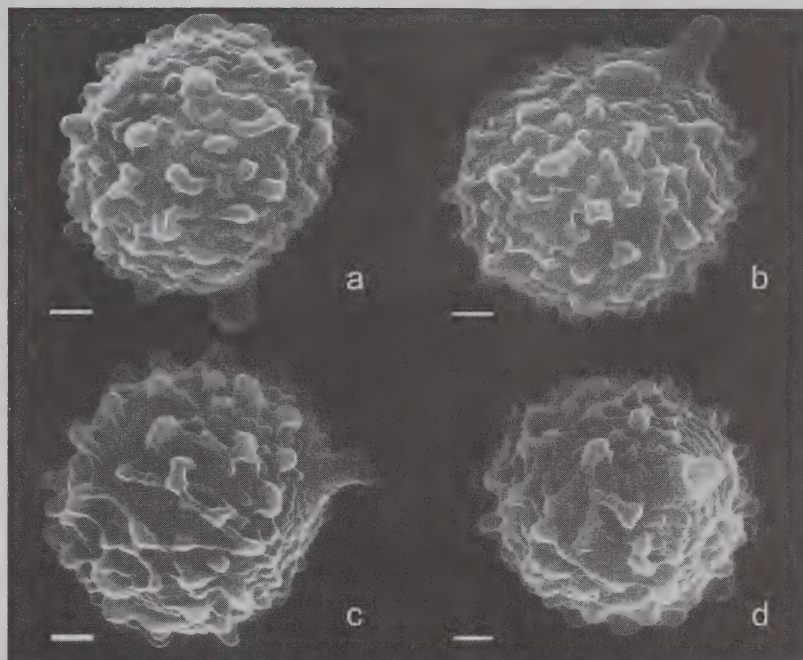


Fig. 5. *Lactarius verae-crucis* (López 397).
Pileipellis. Bar = 20 μ m.

Notes: This species has been sporadically collected since its description (Singer 1973, 1975, Singer et al. 1983). The records from Mexico and Costa Rica confirm that it is associated with tropical flora but its interactions with specific trees have not yet been studied.

Lactarius luteopus Verbeken is a tropical African species which presents a set of morphological features comparable to *L. verae-crucis*, i.e. basidiome colour, dry surfaces, distant lamellae, spore print colour, basidiospore ornamentation pattern, septate pleurocystidia, two-layered pileipellis and sphaerocytes in both hypodermium and lamellae trama. Even the basidiospore ornamentation in both taxa, as observed in the examined material, shares a similar pattern. *Lactarius luteopus*, however, differs in having more elongate basidiospores ($Q = 1.26\text{--}1.41$) and lacking both cheilocystidia and hyphal elements that project from the subpellis or context. The similarity between *L. verae-crucis* and *L. luteopus*, the latter a member of subgenus *Lactiflui* (Burl.) Hesler & A.H. Sm., sensu Verbeken (2001), suggests considering *L. verae-crucis* also in this group. As *Lactarius verae-crucis* represents the type species of sect. *Polysphaerophori*, we should treat this section, at least with *L. verae-crucis*, as part of subgenus *Lactiflui*.



Figs. 6. *Lactarius verae-crucis* basidiospores under SEM.

A-b. López 397, c-d. Capello 47. Bar = 10 μ m.

Acknowledgements

We acknowledge the curators of the herbaria BR, ENCB, FCME and NYS for the loan of specimens. We express our thanks to Drs. K. Das (Agharkar Research Institute), Greg Mueller (Field Museum of Natural History of Chicago) and Shaun Pennycook (Mycotaxon Nomenclature Editor) for reviewing the manuscript and providing valuable suggestions. Montoya and Bandala appreciate the collaboration of Biologists J.C. Corona, D. Jarvio and T. Mayo during fieldwork. Part of this research was supported by CONACYT (project 52342 to L. Montoya).

Literature cited

- Basso MT. 1999. *Lactarius* Pers. Fungi Europaei 7. Mykoflora, Alassio.
- Bessette AE, Bessette AR, Fischer DW. 1997. Mushrooms of Northeastern North America. Syracuse University, Syracuse.
- Burlingham G. 1908. A study of *Lactariae* of the United States. Memoirs of the Torrey Botanical Club 14: 99-109.
- Courtecuisse R, Duhem B. 1994. Les Champignons de France. Eclectis, Paris.
- Das K, Sharma JR, Montoya L. 2004. *Lactarius* in Kumaon Himalaya 3: A new species of subgenus *Lactifluus*. Mycotaxon 90: 285-290.
- Halling RE. 2001. Ectomycorrhizae: co-evolution, significance, and biogeography. Ann. Missouri Bot. Garden 88: 5-13.

- Halling RE, Mueller GM. 2002. Agarics and boletes of Neotropical oakwoods. In: Watling R, Frankland JC, Ainsworth AM, Isaac S, Robinson CM. Tropical Mycology vol. I, Macromycetes. CAB International, Wallingforth.
- Hesler LR, Smith AH. 1979. North American Species of *Lactarius*. University of Michigan, Ann Arbor.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I. The Herbaria of the world. 8th edn. New York.
- Kornerup A, Wanscher JH. 1967. Methuen Handbook of Colour. 2nd edn. Methuen, London.
- Marchand A. 1980. Champignons du nord et du midi, tome 6. Société Mycologique Pyrénées Méditerranées Perpignan.
- Montoya L. 2000. Estudio del género *Lactarius* Pers. (*Fungi*, *Basidiomycotina*, *Russulales*) en México. Ph. D. Thesis, Universidad de Alcalá, Spain.
- Montoya L, Guzmán G, Bandala VM. 1990. New records of *Lactarius* from Mexico with discussion of the known species. *Mycotaxon* 38 : 349-395.
- Montoya L, Bandala VM, Guzmán G. 1996. New and interesting species of *Lactarius* from Mexico, including scanning electron microscope observations. *Mycotaxon* 57: 411-424.
- Montoya L, Bandala VM. 2003. Studies on *Lactarius*: a new combination and two new species from Mexico. *Mycotaxon* 85: 393-407.
- Montoya L, Bandala VM. 2005. Revision of *Lactarius* from Mexico: Additional new records. *Persoonia* 18: 471-483.
- Montoya L, Bandala VM, Halling R. 2003. *Lactarius furcatus* in Mexico and Costa Rica. *Mycotaxon* 87: 311-316.
- Mueller G, Halling R. 1995. Evidence of high biodiversity of *Agaricales* (*Fungi*) in neotropical montane *Quercus* forests, pp. 303-312. In: Churchill SP, Balslev H, Forero E, Luteyn JL (eds). Biodiversity and Conservation of Neotropical Montane forests. New York Botanical Garden, New York.
- Munsell Soil Colour Charts (1994). Macbeth, New Windsor.
- Murrill WA. 1938. New Florida agarics. *Mycologia* 30: 359-371.
- Peck Ch. 1896. New species of *Fungi*. Bulletin of the Torrey Botanical Club 23: 411-420.
- Peck Ch. 1902. Report of the State Botanist 1901. Bulletin New York State Museum 54: 931-984.
- Peck Ch. 1902a. Report of the State Botanist 1902. Bulletin New York State Museum 67: 3-194.
- Phillips R. 1991. Mushrooms of North America. Little, Brown and company, Boston.
- Rzedowski J. 1978. Vegetación de México. Limusa, México, D.F.
- Singer R. 1973. Diagnoses fungorum novorum agaricalum, III. Beihefte Sydowia 7: 1-106.
- Singer R. 1975. Tropical *Russulaceae*: *Lactarius* Sect. *Polysphaerosphori* in the Gulf Area. *Nova Hedwigia* 26: 897-901.
- Singer R. 1990. *Agaricales* new for Mexico or Central America. *Anales Instituto de Biología de la UNAM serie Botánica* 60: 27-36.
- Singer R, Araujo I, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the Neotropical Lowlands, especially Central Amazonia. Cramer, Vaduz.
- Smith AH, Weber NS. 1985. A field guide to southern mushrooms. University of Michigan, Ann Arbor.
- Smithe FB. 1975. Naturalist's Color Guide. The American Museum of Natural History, New York, USA.
- Styles BT. 1993. Genus *Pinus*: a Mexican Purview, pp. 397-420. In Rammamorthy TP, Bye R, Lot A, Fa J (eds). Biological Diversity of Mexico. Origins and distribution. Oxford Univ., NY.
- Verbeken A. 2001. Studies in Tropical African *Lactarius* species. 10. Infrageneric classification. *Mycotaxon* 77: 435-444.

Myxomycetes from Sonora, Mexico. 3: National Forest Reserve and Wildlife Refuge, Ajos-Bavispe

MARCOS LIZÁRRAGA¹, GABRIEL MORENO², MARTÍN ESQUEDA³,

ALFONSO SÁNCHEZ³ & MARTHA CORONADO⁴

*gabriel.moreno@uah.es

¹Universidad Autónoma de Ciudad Juárez

Anillo Envolverte Pronaf y Estocolmo s/n, Ciudad Juárez 32300, Chihuahua. México

²Dpto. Biología Vegetal, Fac. Biología, Universidad de Alcalá,
28871 Alcalá de Henares 28871, Madrid. España

³Centro de Investigación en Alimentación y Desarrollo
A.C. Apartado Postal 1735, Hermosillo 83000, Sonora, México

⁴Centro de Estudios Superiores del Estado de Sonora
Apartado Postal 11, Admón. 11, Hermosillo 83000, Sonora, México

Abstract – Twenty-four species of myxomycetes from the national forest reserve and wildlife refuge, Ajos-Bavispe, located in Sonora, México, were studied. Nineteen taxa are new records for the Sonoran myxobiota; these are *Arcyria cinerea*, *Ceratiomyxa fruticulosa*, *Comatricha elegans*, *C. tenerrima*, *Craterium obovatum*, *Diderma spumarioides*, *Echinostelium apitectum*, *Lamproderma scintillans*, *Licea minima*, *L. variabilis*, *Perichaena depressa*, *Physarum album*, *P. bivalve*, *P. flavicomum*, *P. javanicum*, *P. leucophaeum*, *P. leucopus*, *P. tenerum* and *Willkomlangaea reticulata*. There are now 66 taxa known, including the new records. The studied species are discussed and photomicrographs of their macro- and microscopic characters are given for some of them.

Key words - Myxomycota, chorology, taxonomy, SEM

Introduction

This is the third contribution to the knowledge of the myxomycetes of Sonora, México, which was initiated by Pérez-Silva et al. (2001) and Moreno et al. (2004, 2006). These authors cited 47 taxa for Sonora, with 23 of them from the National Forest Reserve and Wildlife Refuge Ajos-Bavispe (NFAB). Nineteen new records of myxomycetes for Sonora are included in the present study, all of them from the NFAB. Sixty-six taxa are now known for Sonora, including the new records, with 42 recorded from NFAB.

The survey was conducted at NFAB. Seven types of vegetation were sampled seasonally. These were pine-oak gallery forest, pine-oak forest on other sites, oak forest, oak open forest, microphyllous desert scrub, mezquital and subtropical scrub. The specimens were collected in the field and cultivated in moist chambers. Collections are kept in the mushroom collection of the "Centro de Estudios Superiores del Estado Sonora" (CESUES) and the herbarium of the University of Alcalá, Spain (AH).

All sporocarps were mounted in Hoyer's medium. SEM photographs were taken after applying the critical point drying technique as described in Moreno et al. (2002). The locality for each species is provided according to Table 1; names of collectors are abbreviated: A. Bautista (AB), S. Gómez (SG), M. Lizárraga (ML), A. Sánchez (AS) and M. Rivera (MR); date and herbarium. First records for the Sonoran myxobiota are indicated by an asterisk.

Table 1. Sampling localities in National Forest Reserve and Wildlife Refuge Ajos-Bavispe.

Localities	N	W	Altitude	Vegetation
Municipality of Cananea				
1. El Campamento	30°58'22"	109°57'38"	1997 m	POGF
Municipality of Bacoachi				
2. El Manzano	30°56'04"	109°57'58"	2218 m	POF
Municipality of Fronteras				
3. El Frijolito	30°56'35"	109°57'21"	2286 m	POF
4. La Valdeza	30°38'06"	109°47'22"	1546 m	OOF
Municipality of Cumpas				
5. Km 8 Moctezuma-Antena	29°58'53"	109°39'52"	818 m	MDS
6. El Encinal	30°00'02"	109°33'29"	1653 m	OF
7. La Selva	29°57'41"	109°36'55"	881 m	SS
8. El Mezquital	29°57'26"	109°38'23"	882 m	M

Vegetation types: Pine-Oak Gallery Forest (POGF); Pine-Oak Forest (POF); Oak Forest (OF); Oak Open Forest (OOF); Microphyllous Desert Scrub (MDS); Mezquital (M); and Subtropical Scrub (SS).

List of Species

**Arcyria cinerea* (Bull.) Pers., Syn. Meth. Fung.: 184 (1801)

SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 24.VIII.2005, on rotten wood of *Quercus* sp., CESUES 7246. LOCALITY 7, leg. ML & AB, 27.VIII.2005, on rotten wood of *Prosopis* sp., CESUES 7258.

Observations: Although this taxon is widely distributed in Mexico (Illana et al. 2000, Rodríguez-Palma et al. 2002, Lado et al. 2003, Lizárraga et al. 2003a,b), this is the first record for Sonora.

**Ceratiomyxa fruticulosa* (O.F. Müll.) T. Macbr., N. Amer. Slime-Moulds: 18 (1899)

SPECIMENS STUDIED: LOCALITY 7, leg. ML & AB, 27.VIII.2005, on rotten wood of *Prosopis* sp., CESUES 7257.

Observations: Widely distributed in México (Illana et al. 2000, Lado et al. 2003, Lizárraga et al. 2003a).

**Comatricha elegans* (Racib.) G. Lister, Guide Brit. Mycetoza, ed. 3: 31 (1909)

SPECIMENS STUDIED: LOCALITY 2, leg. ML, SG, AB, AS & MR, 22.II.2005, on decayed wood of *Pinus engelmannii*, CESUES 7231. Cultivated in moist chamber (22.IV.2005), fruiting on 10.V.2005.

Observations: Because of its small sporocarps, fibrous stalk that is as long as the diameter of the sporotheca, weakly anastomosed capillitium which at the base forms a small net and verrucose spores 7-9 μm diam., the Sonoran collection was determined as *Comatricha elegans* var. *pallens* G. Lister. Only two sporocarps were obtained in moist chambers, and these were mounted in Hoyer's medium. It has been infrequently reported for México: Jalisco, Veracruz (Illana et al. 2000) and Chihuahua (Lizárraga et al. 2005b).

**Comatricha tenerrima* (M.A. Curtis) G. Lister, Guide Brit. Mycetoza, ed. 4: 39 (1919)

Figs. 1-2

SPECIMENS STUDIED: LOCALITY 5, leg. ML & AB, 24.VIII.2005, on dead wood of *Prosopis* sp., CESUES 7249.

Observations: Characterized by its 7-8 μm diam. spores which are pale brown and weakly ornamented with warts by transmitted light. Spore ornamentation is observed as baculate under SEM, and these have a coralloid apex forming a typical stelliform ornamentation, and the capillitium is wavy. Recorded for several Mexican states (Illana et al. 2000, Lado et al. 2003, Lizárraga et al. 2005b).

**Craterium obovatum* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 64 (1873)

Figs. 3-4

SPECIMENS STUDIED: LOCALITY 4, leg. ML & AB, 24.VIII.2005, on litter leaves of *Quercus* sp., CESUES 7248 in AH 31786, CESUES 7248a, 7248b, 7248c.

Observations: This foliicolous species is recognized by its stalked, crowded sporocarps, and globose sporothecae which are cylindrical to more or less pyriform. Spores 13-15 μm diam., globose to subglobose, dark by transmitted light, conspicuously spinose warted ornamentation and black spore-mass; under SEM, the spines are as baculate and more or less irregularly coralloid. This species is little known in the Mexican myxobiota: Baja California and Veracruz (Illana et al. 2000).

**Diderma spumarioides* (Fr.) Fr., Syst. Mycol 3: 104 (1829)

Figs. 5-6

SPECIMENS STUDIED: LOCALITY 4, leg. ML & AB, 24.VIII.2005, on dead leaves of *Quercus* sp., CESUES 7247.

Observations: This species belongs to *Diderma spumarioides*, *D. crustaceum* and *D. donkii* complex, the members of which are very difficult to separate due to the dissimilarity of descriptions of these taxa by various authors (Lister 1911, 1925; Martin & Alexopoulos 1969, Nannenga-Bremekamp 1974, Neubert et al. 1995) and by the existence of intermediate collections between these species. The differences given in the monograph of the genus by Buyck (1982) are complicated and are difficult to apply to the Sonoran collection. The studied collection is characterized by its globose sporocarps; peridium double and strongly attached, dehiscence apical and irregular; columella globose, whitish; capillitium hyaline, more or less wavy with some pale nodules; spores of 10-12 μm diam., with crowded verrucae. Although spores are larger than size indicated by Buyck (1982): (8.8-)9.04-9.73(-10.1) μm , we decided to use the denomination of Fries. Spore ornamentation is observed as baculate under SEM, and these have conforming short crests. The species was previously reported in México for Estado de México, Jalisco (Illana et al., 2000) and Quintana Roo (Lado et al. 2003).

Didymium clavus (Alb. & Schwein.) Rabenh., Deutschl. Krypt.-Fl. 1: 280 (1844)

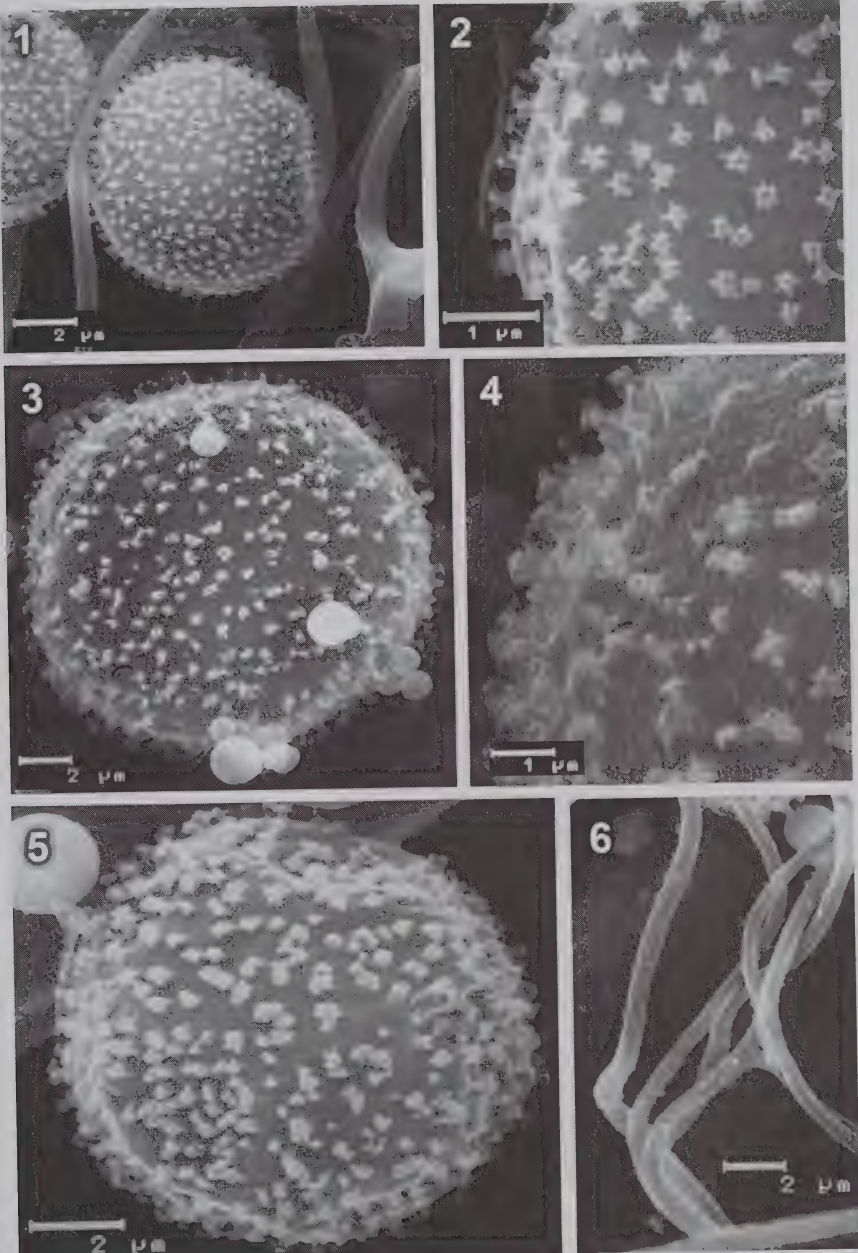
SPECIMENS STUDIED: LOCALITY 4, leg. ML & AB, 25.VIII.2005, on fallen leaves of *Quercus* sp., CESUES 7250.

Observations: This taxon is recorded for Baja California, Chiapas, Yucatán (Illana et al. 2000), Veracruz (Lado et al. 2003), Chihuahua (Lizárraga et al. 2005a) and Sonora (Moreno et al. 2006).

**Echinostelium apitectum* K.D. Whitney, Mycologia 72(5): 954 (1980)

SPECIMENS STUDIED: LOCALITY 5, leg. ML, SG, AB, AS & MR, 24.II.2005, on dead wood of *Prosopis glandulosa*, CESUES 7234. Cultivated in moist chamber (22.IV.2005), fruiting on 26.IV.2005.

Observations: A permanent slide was prepared of several sporocarps: Stalk 120-150 μm long, hollow, filled with granular materials, broad at the base, attenuating at apex which supports the sporotheca of 11 μm diam.; spores of 6-8 μm diam.,



Figs. 1-2 *Comatricha tenerrima* CESUES 7249: 1. Spore. 2. Detail of spore-ornamentation. Figs. 3-4 *Craterium obovatum* AH 31786: 3. Spore. 4. Detail of spore ornamentation. Figs. 5-6 *Diderma spumarioides* CESUES 7247: 5. Spore. 6. Detail of capillitium.

hyaline. Previously observed in moist chamber, on substrata originating from Baja California Sur (Lizárraga et al. 2004), Tlaxcala (Rodríguez-Palma et al. 2002) and Chihuahua (Lizárraga et al. 2005b).

Fuligo cinerea (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 19: 33 (1896)
= *F. stercoriformis* (Zopf) Racib., Hedwigia 26: 111 (1887)

SPECIMENS STUDIED: LOCALITY 5, leg. ML & AB, 26.VIII.2005, on cow dung, CESUES 7253.

Observations: This new coprophilous record corroborated the antique denomination and the establishment of *Fuligo stercoriformis* (Zopf) Racib. as synonymous. In México, it is recorded for Baja California, Nuevo León, Sonora (Illana et al. 2000) and Chihuahua (Lizárraga et al. 2003a).

Fuligo septica (L.) F.H. Wigg., Prim. Fl. Holsat: 112 (1780)

SPECIMENS STUDIED: LOCALITY 8, leg. ML & AB, 27.VIII.2005, on ant's land, CESUES 7252.

Observations: This taxon is well-recorded in México (Illana et al. 2000, Pérez-Silva et al. 2001, Lizárraga et al. 2003b, 2005a).

**Lamproderma scintillans* (Berk. & Broome) Morgan,
J. Cincinnati Soc. Nat. Hist. 16: 131 (1894)

Figs. 7-8

SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 23.VIII.2005, on dead leaves, CESUES 7236. *Ibidem*, 24.VIII.2005, CESUES 7244.

Observations: Determined without difficulty by its foliicolous habit, small size; peridium iridescent; capillitium dark and radiating from the columella with the bases hyaline. Spores of 7-9 µm diam., verrucose; a conspicuous baculate ornamentation under SEM, which is regularly distributed. It was previously known from several Mexican states (Illana et al. 2000, Lado et al. 2003, Lizárraga et al. 2003a) and a new record for Sonora.

Licea kleistobolus G.W. Martin, Mycologia 34(6): 702 (1942)

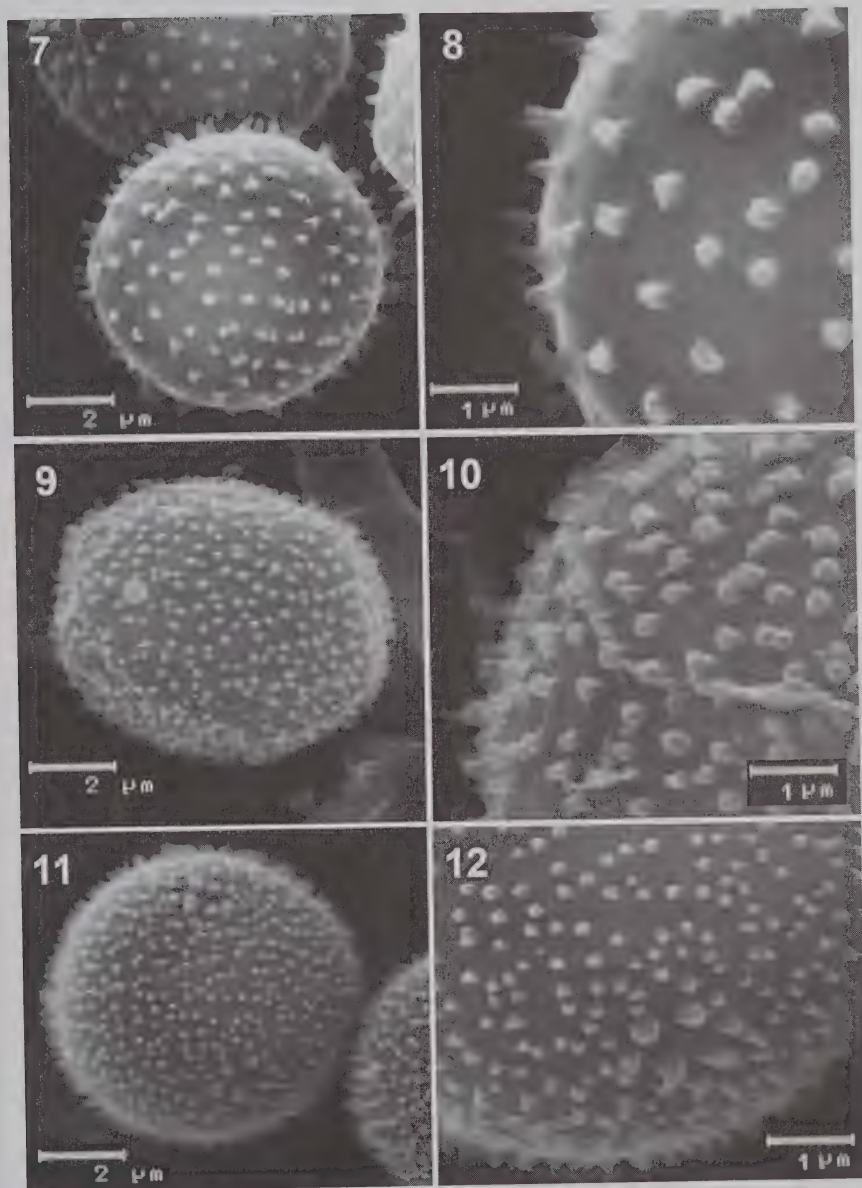
SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 24.VIII.2005, on rotten wood of *Quercus* sp., CESUES 7245.

Observations: This species is recorded for Baja California (Lizárraga et al. 2004), Distrito Federal (Braun & Keller 1986), Tlaxcala (Rodríguez-Palma et al. 2002), Chihuahua (Lizárraga et al. 2003a) and Sonora (Moreno et al. 2006).

**Licea minima* Fr., Syst. Mycol. 3: 199 (1829)

SPECIMENS STUDIED: LOCALITY 3, leg. ML & AB, 23.VIII.2005, on dead wood of *Pinus* sp., CESUES 7238.

Observations: Characterized by its polygonal sporocarps, ferrugineous spore-mass, deep red peridium with granular materials, the peridial plates edged



Figs. 7-8 *Lamproderma scintillans* CESUES 7236: 7. Spore. 8. Detail of spore ornamentation. Figs. 9-10 *Physarum javanicum* AH 31787: 9. Spore. 10. Detail of spore ornamentation. Figs. 11-12 *Physarum tenerum* AH 31788: 11. Spore. 12. Detail of spore ornamentation.

with protuberances or papillae; spores 9-11 μm diam., with conspicuous ornamentation but some areas appearing smooth. Recorded for Jalisco (Villarreal 1990), Tlaxcala (Braun & Keller 1976, Rodríguez-Palma et al. 2002) and Chihuahua (Lizárraga et al. 2003a).

**Licea variabilis* Schrad., Nov. Gen. Pl.: 18 (1797)

SPECIMENS STUDIED: LOCALITY 2, leg. ML, SG, AB, AS & MR, 22.II.2005, on dead wood of *Pinus engelmannii*, CESUES 7230.

Observations: Recognized by its short and irregular plasmodiocarps; membranous peridium with an irregular dehiscence; spores of 11-13 μm diam., greenish spore-mass and spores with olivaceous hues by transmitted light, strongly spinuloses. Previously cited in Mexico for Baja California (Illana et al. 2000) and Chihuahua (Lizárraga et al. 2003a).

Mucilago crustacea F.H. Wigg., Prim. Fl. Holsat.: 112 (1780)

SPECIMENS STUDIED: LOCALITY 2, leg. ML & AB, 23.VIII.2005, on cones of *Pinus ayacahuite*, CESUES 7239.

Observation: This taxon is commonly recorded in Mexico (Illana et al. 2000, Moreno et al. 2006).

**Perichaena depressa* Lib., Pl. Crypt. Arduenna: 378 (1837)

SPECIMENS STUDIED: LOCALITY 6, leg. ML, SG, AB, AS & MR, 24.II.2005, on dead wood of *Quercus* sp., CESUES 7233. Cultivated in moist chamber (28.II.2005), fruiting on 20.III.2005.

Observations: Recognized by its yellowish capillitium, verrucose surface, with numerous constrictions; spores 10-12 μm diam., yellowish by transmitted light. This species has been frequently cited for the Mexican myxobiota (Illana et al. 2000, Rodríguez-Palma et al. 2002, Lado et al. 2003, Lizárraga et al. 2003a,b). This is the first record for Sonora.

**Physarum album* (Bull.) Chevall., Fl. Gén. Env. Paris 1: 336 (1826)

= *P. nutans* Pers., Ann. Bot. (Usteri) 15: 6 (1795)

SPECIMENS STUDIED: LOCALITY 2, leg. ML & AB, 23.VIII.2005, on strobilous of *Pinus ayacahuite*, CESUES 7240. Locality 8, leg. ML & AB, 27.VIII.2005, on dead wood of *Prosopis* sp., CESUES 7256.

Observations: Although this taxon has been commonly cited for México (Illana et al. 2000, Lado et al. 2003, Lizárraga et al. 2003a), this is the first record for Sonora.

**Physarum bivalve* Pers., Ann. Bot. (Usteri) 15: 5 (1795)

SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 23.VIII.2005, on dead leaves of *Quercus* sp., CESUES 7237. *Ibidem*, 24.VIII.2005, on rotten wood of *Quercus* sp., next to *Licea kleistobolus*, CESUES 7243.

Observations: This cosmopolitan species has been infrequently recorded from Mexico: Jalisco, Baja California (Illana et al. 2000) and Chihuahua (Lizárraga et al. 2003a).

**Physarum flavicomum* Berk., London J. Bot. 4: 66 (1845)

SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 24.VIII.2005, on cone of *Pinus ayacahuite*, CESUES 7241.

Observations: This species is closely related to *Physarum galbeum* Wingate, but because of its persistent capillitium, yellowish brown stalk and spores with violet hues by transmitted light, we determined the Sonoran specimens as *P. flavicomum*. It is recorded in Mexico for Puebla (Illana et al. 2000) and Quintana Roo (Lado et al. 2003).

**Physarum javanicum* Racib, Hedwigia 37: 53 (1898)

Figs. 9-10

SPECIMENS STUDIED: LOCALITY 8, leg. ML & AB, 27.VIII.2005, on living wood of *Prosopis* sp., CESUES 7254, CESUES 7255 in AH 31787.

Observations: Recognized by its whitish sporocarps; compressed sporotheca that is umbilicate at the apex; solid, rigid capillitium with whitish, elongated nodules; spores 9-11 μm diam., globose, minutely roughened, with a baculate ornamentation under SEM. This species was previously known in Mexico only from Jalisco (Illana et al. 2000).

**Physarum leucophaeum* Fr., Symb. Gasteromyc.: 24 (1818)

SPECIMENS STUDIED: LOCALITY 7, leg. ML, SG, AB, AS & MR, 24.II.2005, on dead wood of *Ambrosia ambrosioides*, CESUES 7235. It was cultivated in moist chamber (22. IV.2005), fruiting in 28.IV.2005.

Observations: Characterized by its lenticular to subglobose, whitish sporothecae; stalk dark at base; peridium with irregular dehiscence. It is not common in moist chamber culture. This species has been infrequently recorded for México (Illana et al. 2000, Lizárraga et al. 2003a,b).

**Physarum leucopus* Link, Ges. Naturf. Freunde Berlin Mag. 3: 27 (1809)

SPECIMENS STUDIED: LOCALITY 6, leg. ML & AB, 25.VIII.2005, on dead leaves of *Quercus* sp., CESUES 7251.

Observations: Characterized by its whitish sporocarps; solid, columnar stalk covered with lime; spores 8-10 μm diam., verrucose, some areas with more crowded warts. This species is known in the Mexican myxobiota for Baja California Sur, Jalisco, Tlaxcala and Veracruz (Illana et al. 2000).

**Physarum tenerum* Rex,

Proc. Acad. Nat. Sci. Philadelphia 42: 192 (1890)

Figs. 11-12

SPECIMENS STUDIED: LOCALITY 1, leg. ML & AB, 24.VIII.2005, on dead wood of *Quercus* sp., CESUES 7242 in AH 31788, CESUES 7242a.

Observations: Recognized by its large, columnar, calcareous, rigid, pale yellow, with lime-crystals inside stalk; sporotheca globose, generally pendulous, very fragile and easily separated from stalk. Peridium single, whitish, with conspicuous scattered calcic granules. Columella absent. Capillitium ornamented with small and yellowish nodules. Spores 8-10 μm diam., with violet hues by transmitted light, ornamented with small warts, which are observed as baculate under SEM.

The studied collections possessed a stalk, sporotheca, and capillitium with spherical, yellowish granules, these morphologic and macroscopic characters are related to *P. tenerum*. Reported from Chiapas (Emoto 1933; unpublished records of Matuda), Quintana Roo (Lado et al. 2003) and Yucatán (Stephenson et al. 2003).

* *Willkomlangaea reticulata* (Alb. & Schwein.) Kuntze, Revis. Gen. Pl. 2: 875 (1891)

SPECIMENS STUDIED: LOCALITY 1, leg. ML, SG, AB, AS & MR, 24.II.2005, on dead wood of *Quercus gambelii*, CESUES 7232. It was cultivated in moist chamber (22.IV.2005), fruiting in 3.V.2005.

Observations: Characterized by its plasmodiocarpic sporocarps, superficially ornamented with reddish zones, and badhamioid capillitium. There are few records of this species for México: Jalisco, Nuevo León (Illana et al. 2000), Quintana Roo (Lado et al. 2003) and Chihuahua (Lizárraga et al. 2005b).

Acknowledgments

The authors thank SEMARNAT-CONACYT (Grant 2002-C01-0409), DGAPA (Grant IN206901 (México) and "Ministerio de Ciencia y Tecnología, Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica REN2002-01965". M. Lizárraga wishes to thank "Vicerrectorado de Investigación, Universidad de Alcalá", for financing a research stage in September 2005. A. Gutiérrez (CIAD) for logistic help. We want to express our gratitude to Dr. S.L. Stephenson and Mr. D.W. Mitchell for reviewing the manuscript and their useful comments, to L. Monje "Gabinete de Dibujo y Fotografía, Universidad Alcalá" for his help with the digital treatment of the photos and we wish to thank J.A. Pérez and A. Priego "Servicio de Microscopía Electrónica, Universidad de Alcalá" for their invaluable help with the SEM.

Literature Cited

- Braun KL, Keller HW. 1976. Myxomycetes of Mexico I. Mycotaxon 3: 297-317.
- Braun KL, Keller HW. 1986. Myxomycetes of Mexico III. Revista Mexicana de Micología 2: 25-139.
- Buyck B. 1982. The genus *Diderma* Persoon (Myxomycetes) in Belgium. Bulletin du Jardin Botanique National de Belgique 52: 165-209.
- Emoto Y. 1933. Myxomyceten aus Mexiko. Botanical Magazine Tokyo 47: 132-135.
- Illana C, Moreno G, Lizárraga M. 2000. Catálogo de Myxomycetes de México. Stapfia 73: 167-186.
- Lado C, Estrada-Torres A, Stephenson SL, Wrigley de Basanta D, Schnittler M. 2003. Biodiversity assessment of Myxomycetes from two tropical forest reserves in Mexico. Fungal Diversity 12: 67-110.

- Lister A. 1911. A monograph of the Mycetozoa. 2nd ed. British Museum, London.
- Lister A. 1925. A monograph of the Mycetozoa. 3rd ed. British Museum, London.
- Lizárraga M, Moreno G, Singer H, Illana C. 2003a. Myxomycetes from Chihuahua, Mexico. Mycotaxon 88: 409-424.
- Lizárraga M, Moreno G, Illana C, Solis F. 2003b. Myxomycetes in the state of Sinaloa, (Mexico) II. Mycotaxon 88: 425-432.
- Lizárraga M, Moreno G, Illana C. 2004. Contribución al estudio de los Myxomycetes de la Península de Baja California, México. Boletín de la Sociedad Micológica de Madrid 28: 43-53.
- Lizárraga M, Moreno G, Illana C. 2005a. Myxomycetes from Chihuahua, Mexico. II. Österreichische Zeitschrift Pilzkunde 14: 105-121.
- Lizárraga M, Moreno G, Illana C, Singer H. 2005b. Myxomycetes from Chihuahua, Mexico III. Mycotaxon 93: 75-88.
- Martin GW, Alexopoulos CJ. 1969. The Myxomycetes. University of Iowa Press, Iowa.
- Moreno G, Sánchez A, Singer H, Illana C, Castillo A. 2002. A study on nivicolous Myxomycetes. The genus *Lamproderma* I. Fungi Non Delineati 19: 1-66.
- Moreno G, Illana C, Esqueda M, Castillo A, Pérez-Silva E. 2004. Notes on Myxomycetes from Mexico II. Boletín de la Sociedad Micológica de Madrid 28: 55-63.
- Moreno G, Lizárraga M, Esqueda M, Pérez-Silva E, Herrera T. 2006. Myxomycetes de Sonora, Mexico. II: Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe. Revista Mexicana de Micología 22: 13-23.
- Nannenga-Bremekamp NE. 1974. De Nederlandse Myxomyceten. Koninklijke Nederlandse Natuurhistorische Vereniging, Zutphen.
- Neubert H, Nowotny W, Baumann K, Marx H. 1995. Die Myxomyceten. Vol. 2 *Physarales*. Karlheinz Baumann Verlag, Gomeriingen.
- Pérez-Silva E, Herrera T, Esqueda M, Illana C, Moreno G. 2001. Myxomycetes of Sonora, Mexico. I. Mycotaxon 77: 181-192.
- Rodríguez-Palma M, Varela-García A, Lado C. 2002. Corticolous myxomycetes associated with four tree species in Mexico. Mycotaxon 81: 345-355.
- Stephenson SL, Estrada-Torres A, Schnittler M, Lado C, Wrigley de Basanta D, Ogata N. 2003. Distribution and ecology of myxomycetes in the forests of Yucatán. 241-259, in A Gómez-Pompa, MF Allen, SL Fedick, JJ Jiménez-Osornio (eds.), The Lowland Maya Area. Three millennia at the human-wildland interface. The Haworth Press, Binghamton.
- Villarreal L. 1990. Estudios sobre los myxomycetes de México I. Nuevos registros. Micología Neotropical Aplicada 3: 67-79.

New species and new records of *Graphis* from India with partially carbonized exciples and transseptate ascospores

BHARATI ADAWADKAR & URMILA MAKHIJA

UV_Makhija@hotmail.com

Agharkar Research Institute

G.G. Agarkar Road, Pune - 411004, India

Abstract—A key is presented to 57 species of *Graphis* recorded from India. *Graphis alboglaucescens*, *G. eburnea*, *G. filiformis*, *G. meghalayaensis*, *G. salacinilongiramea*, *G. subvittata* and *G. valparaiensis* are described as new to science. *Graphis* cf. *bakeri*, *G. furcata*, *G. immersella*, *G. malacodes*, *G. olivacea*, *G. rigidula*, *G. sapii*, *G. stenotera*, *G. urandae*, are recorded for the first time from India. One species remains unnamed.

Keywords—lichenized fungi, *Ascomycetes*, taxonomy, *Graphidaceae*

Introduction

The family *Graphidaceae* with 918 species world wide (Kirk et al. 2001) is one of the largest group of crustose lichens which are widely distributed, mainly in tropical regions. Several lichenologists have contributed to the knowledge of the family *Graphidaceae*, through publications recording species from Ceylon (Leighton 1869), the Philippines, and Siam (Vainio 1921a, b), Brazil (Redinger 1935), Mexico (Wirth & Hale 1963), Japan and adjacent areas (Nakanishi 1966, Nakanishi & Harada 1999, Nakanishi et al. 2002, 2003), Dominica (Wirth & Hale 1978), Thailand (Nakanishi et al. 2001), India (Awasthi 2000), Guiana (Sipman 1994) and from Australia (Archer 1999, 2001a, b, c, 2004).

The family *Graphidaceae* is also one of the largest and widely distributed groups of lichens in India and is well represented mainly by the artificial genera *Graphina* (60 species), *Graphis* (74 species), *Phaeographina* (25 species), and *Phaeographis* (32 species) (Awasthi 1991, 2000) but is still inadequately studied and the taxa reported so far are mostly in need of revision. Also, with Staiger's (2002) revision, genera are now recognized differently. The Indian *Graphidaceae* have been recorded in many scattered publications (Awasthi & Singh 1975, Awasthi & Singh 1977, Patwardhan & Kulkarni 1976, 1979, Kulkarni 1977,

Nagarkar & Patwardhan 1982, Singh 1984, Singh & Sinha 1994 and Makhija et al. 1992a, b) but there has never been a comprehensive treatment of the family in India.

We are currently undertaking a detailed survey of *Graphidaceae*. A revision of the genus *Graphis* Adans. sensu Müller Arg. (1880, 1882) from India, revealed the occurrence of 145 species which are now placed in different genera sensu Staiger (2002) (Adawadkar & Makhija 2004, 2005, Makhija & Adawadkar 2003, 2005a, b, Makhija et al. 2005a, b).

In our previous papers we have recorded ten new species of the lichen genus *Graphis* from the Andaman and Nicobar Islands of India (Makhija et al. 2005a, Makhija & Adawadkar 2005b) and published an account of ten species, with transseptate ascospores and completely carbonized exciples, from India (Adawadkar & Makhija 2006).

In the present paper we have recognized fifty seven species of *Graphis* with transseptate ascospores and partially carbonized exciples from India. Of these, 16 species are recorded for the first time from India including 7 species new to science. A key to the species of *Graphis* with transseptate ascospores and partially carbonized exciples from India is given. One species has not been formally described and remains unnamed.

Materials and methods

Sections of the thalli and the ascomata were mounted in water, 10% KOH (K), Lugol's solution (I), and lactophenol cotton-blue (LPCB). All measurements were made in water. The iodine reaction of the hymenium was studied in Lugol's iodine solution after pretreatment with K. The secondary products of the specimens were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970 Culberson 1972 White & James 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-diethylether-formic acid (130:100:20) and toluene-ethyl acetate-formic acid (139:83:8 ml). All specimens were observed under UV light (365 nm).

We have had available to us the morphological and chemical data, based on the re-examination of type or authentic material of several taxa in the *Graphidaceae* together with photographs of type specimens from the late Dr. Mason Hale, which was provided to us by him for our studies during his several visits to our laboratory at ARI.

**Key to the Indian *Graphis* species with transseptate ascospores
and partially carbonized exciples**

- Exciple laterally carbonized, carbonization borders hymenium **Group I**
Exciple carbonized only at the tips, carbonization does not border hymenium .. **Group II**

Group I

- 1a. Exciples not striate 2
1b. Exciples striate 27
2a. Ascospores exceeding 100 μm in length 3
2b. Ascospores not exceeding 100 μm in length 4
3a. Thallus saxicolous, corticate, gray; ascomata up to 9 mm long, emergent,
simple to branched, margin thick; ascospores 11–27-transseptate,
44–133 x 9–16 μm in size; norstictic and salazinic acids present;
from Meghalaya and Nagaland *G. longispora* D.D. Awasthi & S.R. Singh
3b. Thallus corticolous, grayish, rough, corticate; ascomata 2–5 mm long,
black, semi-emergent; exciple indistinct at the base; ascospores
15–20-transseptate, 70–110 x 10–14 μm in size; from Kerala, Tamil Nadu
..... *G. hossei* Vain.
4a. Thallus foliicolous.
Thallus foliicolous, corticate; ascomata 0.5–1.3 long, unbranched, flexuose;
exciple not present at the base, carbonized; ascospores 7–11-transseptate,
28–56 x 5–8 μm in size; from Palni hills *G. pavoniana* Fée
[Syn. *G. foliicola* var. *major* D.D. Awasthi & Kr. P. Singh (Awasthi 1991)]
4b. Thallus corticolous 5
5a. Thallus sorediate.
Thallus corticate, whitish, soredia granular; ascomata 5–10 mm long,
concolorous, flexuose, dendroidly branched; disc pruinose; exciple
indistinct at base; outer surface not smooth, indistinctly incised;
ascospores 6–8-transseptate, 27–32 x 7–10 μm ; stictic and constictic
acids present; from Meghalaya *G. sorediosa* Nagarkar & Patw.
5b. Thallus lacking soredia and isidia 6
6a. Lichen substances present 7
6b. Lichen substances absent 23
7a. Protocetraric acid present
Thallus greenish, warty, corticate; ascomata 0.2–3 mm long, immersed, simple
to branched, ends acute to subacute; exciple present below; ascospores
7–9-transseptate, 21–34 x 4–5 μm in size; constictic, protocetraric, and stictic
acids present; from Andaman Islands *G. distincta* Makhija & Adaw.
7b. Protocetraric acid absent 8
8a. Only salazinic acid present.
Thallus gray, warty; ascomata up to 5 mm long, black, ends obtuse,
semiemergent; exciple present at the base; ascospores 9–12-transseptate,
42–46 x 4–5 μm in size; salazinic acid present; from Andaman Islands,
Himachal Pradesh and Kerala *G. cf. bakeri*
8b. Salazinic acid may or may not present with other acids 9

- 9a. Only norstictic acid present 10
- 9b. Norstictic and/or other other acids present 11
- 10a. Thallus brownish to greenish gray, smooth, corticate; ascomata 0.5–6 mm long, concolorous, immersed, ends obtuse; disc broad, pruinose; exciple may or may not present at the base; ascospores 8–16-transseptate, 40–46 x 8–12 μm ; norstictic acid present; from Maharashtra *G. pyrrohocheiloides* Zahlbr.
- 10b. Thallus whitish brown, yellowish, smooth, corticated; ascomata up to 10 mm long, thin, black, simple to branched; ends acute; exciple present below; ascospores 7–9-transseptate, 21–25 x 6–8 μm in size; norstictic acid present; from Karnataka *G. filiformis*
- 11a. Ascomata concolorous with the thallus 12
- 11b. Ascomata black 13
- 12a. Thallus silvery white, glossy; ascomata 5–7 mm long, concolorous with thallus, simple to branched, ends acute to subacute, immersed to slightly raised; exciple present below; ascospores 6–7-transseptate, 21–25 x 4–5 μm ; constictic, salazinic and stictic acids present; from Andaman Islands *G. argentea* Makhija & Adaw.
- 12b. Thallus whitish, corticate; ascomata 3–8 mm long, whitish, emergent, unbranched, flexuose; exciple present below, carbonized only at the tip but sometimes laterally carbonized; ascospores 12–15-transseptate, 60–75 x 5–10 μm ; norstictic and salazinic acids; from Arunachal Pradesh, Kerala, Meghalaya, Orissa *G. garoana* Nagarkar & Patw.
- 13a. Ascospores not exceeding 50 μm in length 14
- 13b. Ascospores exceeding 50 μm in length 21
- 14a. Ascomata long exceeding 5 μm in length 15
- 14b. Ascomata short, not exceeding 5 μm in length 17
- 15a. Norstictic acid present.
Thallus whitish, smooth, corticate; ascomata 1–8 mm long, black, simple to branched; exciple present below; ascospores 8–11-transseptate, 25–50 x 7–10 μm in size; norstictic, and stictic acids present; from Karnataka, Kerala, Maharashtra and Tami Nadu *G. guimarana*
- 15b. Norstictic acid absent. 16
- 16a. Thallus whitish, stramineous, ferinaceous, ecorticate; ascomata 1–5 (–7) mm long, black, immersed, simple, radiately to irregularly branched; exciple thin at the base; ascospores 7–9-transseptate, 21–34 x 4–5 μm in size; constictic, salazinic, and stictic acids present; from Andaman Islands *G. insularis* Makhija & Adaw.
- 16b. Thallus whitish gray, corticate; ascomata 1–8 mm long, black, simple to furcate; disc pruinose; exciple present below; ascospores 5–8-transseptate, 20–38 x 5–8 μm ; constictic, stictic acids present; from Maharashtra *G. modesta* Zahlbr.
- 17a. Norstictic acid absent.
Thallus yellowish, rugose; ascomata 1–4 mm long, black, ends acute to obtuse; simple to branched, immersed; exciples thin at the base;

- ascospores 5–7-transseptate, 16–25 x 4–5 μ m in size; constictic and stictic acids present; from Andaman Islands *G. immersella*
- 17b. Norstictic acid present 18
- 18a. Salazinic acid present.
Thallus olivaceous, greenish glaucous, corticate; ascomata 1–3 mm long, black, flexuose, semi emergent, radiately branched; exciple absent below; ascospores 5–8-transseptate, 14–24 x 4–7 μ m in size; salazinic, stictic, and norstictic acids present; from Assam *G. subasahinae* Ngarakar & Patw.
- 18b. Salazinic acid absent 19
- 19a. Ascomata simple.
Thallus greenish glaucous to olivaceous buff, smooth to minutely warty, corticate; ascomata 1–4 mm long, black, ends obtuse, simple, straight, curved; exciple present below; ascospores 9–11-transseptate, (20–) 30–40 x 6–8 μ m in size; constictic, norstictic and stictic acids present; from Karanataka, Kerala, Maharashtra and Tamil Nadu
..... *G. ajarekarii* Patw. & C.R. Kulk.
- 19b. Ascomata branched 20
- 20a. Ascomata simple to rarely branched.
Thallus buff to greenish brown, rough, smooth to plicate, corticate; ascomata 1–2.5 mm long, black, simple, semiemergent; exciple present below; ascospores 3–10-transseptate, 17–42 x 5–9 μ m; constictic, norstictic acids; from Maharashtra *G. librata* C. Knight
- 20b. Thallus glaucous white to whitish gray, smooth to furfuraceous, corticate; ascomata 2–4 mm long, black, immersed, simple to radiately branched; exciple present at base; ascospores 6–9-transseptate, 30–40 x 4–6 μ m; constictic, norstictic and stictic acids present; from Lakshadweep Island
..... *G. caesiella* Vain.
- 21a. Ascomata short, up to 5 mm long.
Thallus pale grayish, corticate; ascomata 1–5 mm long, blackish, immersed to semi-emergent, simple to irregularly branched, ends subacute; exciple present below; ascospores 13–17-transseptate, 63–84 x 4–8 μ m; constictic and stictic acids present; from Andaman Islands
..... *G. sitapurensis* Makhija & Adaw.
- 21b. Ascomata long, more than 5 mm long 22
- 22a. Thallus glaucous to grayish, corticate; ascomata 5–16 mm long, black, immersed to semi-emergent, radiately dichotomously branched; exciple present below; ascospores 8–16-transseptate, 45–87 x 9–10 μ m; stictic acid; from Manipur, Nagaland, Nillgiri hills *G. longiramea* Müll. Arg.
- 22b. Thallus glaucous to grayish, corticated; ascomata 5–12 mm long, black, emergent, radiately dichotomously branched; exciple present below; ascospores 10–18-transseptate, 40–89 x 9–10 μ m; stictic, salazinic (major), hypostictic and hyposalazinic acids; from Karnataka
..... *G. salacinilongiramea*

- 23a. Ascospores exceeding 50 μm in length.
Thallus buff to offwhite, smooth, corticate; ascomata 3–5 mm long, black, simple to branched, immersed to semi-emergent, acute ends; exciple not striate, rarely 1–2 striate, present at the base; ascospores 7–15-transseptate, 25–56 x 8–12 μm ; from Tamil Nadu *G. rigidula*
- 23b. Ascospores not exceeding 50 μm in length 24
- 24a. Ascomata exceeding 10 mm in length.
Thallus glaucous green, membranaceous; ascomata 1–15 mm long, black, simple to sparsely branched, ends acute to round; exciple present below; ascospores 10–14-transseptate, 38–46 x 4–6 μm ; from Nicobar Islands. *G. leptocarpoides* Makhija & Adaw.
- 24b. Ascomata not exceeding 10 mm in length 25
- 25a. Ascomata simple.
Thallus greenish gray, smooth; ascomata simple, unbranched, 0.5–3 mm long, black, semi-emergent, ends subacute; exciple present at the base; ascospores 8–11-transseptate, 21–48 x 4–6 μm in size; from Kerala *G. persicina* Meyen & Flot.
- 25b. Ascomata branched 26
- 26a. Thallus whitish gray, smooth; ascomata 1–7 mm long, black, simple or dendroidly and irregularly branched, acute ends; exciple present below; ascospores 5–7-transseptate, 21–25 x 4–5 μm in size; from Andaman Islands *G. furcata*
- 26b. Thallus grayish green, rough, verrucose, corticate; ascomata branched 3–5 mm long, emergent simple to branched, ends round; exciple present at the base; ascospores 3–6-transseptate, 21–34 x 4–5 μm ; from Andaman Islands and Sikkim *G. urandrae* Vain.
- 27a. Thallus isidiate.
Thallus pale olivaceous buff to citrine green, minutely warty, corticate; ascomata black, 2–7 mm long, simple to dendroidly branched, ends obtuse; exciple with 3–6 striae on each side; ascospores 15–20-transseptate, 60–90(-110) x 8–12 μm ; from Tamil Nadu *G. patwardhanii* C.R. Kulk.
- 27b. Thallus non isidiate 28
- 28a. Ascospores exceeding 100 μm in length 29
- 28b. Ascospores not exceeding 100 μm in length 30
- 29a. Ascomata 1–5 (-6) mm long, emergent, simple, rarely furcate, straight to flexuose; exciple 6–8 striate on each side; ascospores vermiform, 25–28-transseptate, 44–120 (-150) x 7–10 μm ; norstictic acid present; from Manipur *G. celata* Stirt.
- 29b. Ascomata semi-emergent, black, straight to curved, mostly simple, rarely branched, 0.1–7 mm long; exciple with 2–13 striae on each side, partially to completely carbonized; ascospores 4–8/ ascus, oblong, 12–24-transseptate, with one end acute, 25–109 x 4–8 μm ; no lichen substances present; from Maharashtra *G. polystriata* Makhija & A. Dube

- 30a. Lichen substances present 31
- 30b. Lichen substances absent 33
- 31a. Ascospores not exceeding 30 μm in length.
Thallus greenish, rough; ascomata small, 0.5–1.5 mm long, immersed,
simple to branched, ends acute to obtuse; exciple present at the base;
ascospores 5–7-transseptate, 17–25 x 4–5 μm in size; norstictic acid
present; from Keral *G. schiffneri*
- 31b. Ascospores exceeding 30 μm in length 32
- 32a. Thallus undulate, glaucous white, corticate; ascomata 0.5–3 mm long,
simple, curved, sparsely branched, flexuose; exciple thin at the base;
ascospores 8–12-transseptate, (33-) 40–56 x 7–12 μm ; norstictic acid
present; from Assam, Meghalaya and Nagaland *G. inamoena* Zahlbr.
- 32b. Thallus greenish; ascomata 2–5 mm long, mostly simple, flexuose; exciple
indistinctly present at the base; 9–11-transseptate, ascospores 50–60 x
10–12 μm ; norstictic acid present *G. elegans* (Borrer ex Sm.) Ach.
- 33a. Thallus glaucous green, slightly warty, evanescent; ascomata black, up to
7 mm long, simple to branched, semi-emergent; exciple indistinctly
present at the base; ascospores 4–6-transseptate, 16–21 x 4–5 μm ;
from Andaman Islands *G. tenella* Ach.
- 33b. Ascomata 1–5 mm long, black, emergent, simple to rarely branched;
exciple present at the base, multistriate; ascospores 7–9-transseptate,
21–35 x 4–8 μm in size; from Maharashtra *G. duplicata* Ach.

Group II : Exciple carbonized only at the tip

- 1a. Exciple striate 2
- 1b. Exciple without striae 15
- 2a. Thallus isidiate.
Thallus greenish gray, rugulose; ascomata concolorous to brownish,
2–8 mm long, simple to dichotomously branched, flexuose; exciple
indistinctly present at the base, 4–5 striae on each side; ascospores
5–9-transseptate, 21–34 x 4–8 μm in size; stictic and constictic acids
present; from Karnataka *G. isidiza* Adaw. & Makhija
- 2b. Thallus non isidiate 3
- 3a. Lichen substances present 4
- 3b. Lichen substances absent 9
- 4a. Ascospores exceeding 50 μm long.
Thallus olivaceous, verruculose; ascomata 0.5–6 mm long, concolorous
with the thallus, simple, rarely branched, semi-emergent, acute to obtuse
ends; exciple present below, multistriate, more than 10 striate on each side;
ascospores 24–30-transseptate, 84–93 x 5–7 μm in size; norstictic and
stictic acids present; from Meghalaya *G. meghalayaensis*
- 4b. Ascospores not exceeding 50 μm long 5

- 5a. Only stictic acid present.
Thallus grayish green, verruculose, corticate; ascomata black,
0.5–4 mm long, curved, branched, emergent; exciple present below,
with 3–4 striae on each side; ascospores 7–9-transseptate, 21–39 x
4–7 µm in size; stictic acid present; from Maharashtra *G. vittata* Müll. Arg.
- 5b. Stictic and other acids present 6
- 6a. Norstictic acid absent.
Thallus off white; ascomata black, 0.5–6 mm long, mostly unbranched,
ends pointed emergent; exciples 5–6 striae on each side; ascospores
5–9-transseptate, 21–38 x 4–6 µm in size; constictic and stictic acids
present; from Karnataka Kerala and Tamil Nadu *G. stenotera*
- 6b. Norstictic acid present 7
- 7a. Ascomata concolorous with the thallus.
Ascomata 0.5–6 mm long, flush with the thallus, concolorous, more or
less effuse; exciple not striate to mostly 2–4 striae on each side, indistinctly
present at the base; ascospores 7–11-transseptate, 21–49 x 4–6 µm;
constictic, and norstictic acids present; from Maharashtra
. *G. nerurensis* Makhija et al.
- 7b. Ascomata black 8
- 8a. Thallus cream or whitish, rough; ascomata 0.2–2 mm long, emergent, simple,
unbranched, ends round; disc narrow, indistinct; exciple present below,
3–4 striate on each side; ascospores 8–11-transseptate, 25–29 (-33) x
4–5 µm; constictic, stictic and norstictic acids present; from Karnataka
. *G. subvittata*
- 8b. Thallus grayish green; ascomata black, 0.3–9 mm long, immersed to semi-
immersed; simple to branched, flexuose; disc blackish brown to black;
exciple present at the base, 2–3 striate on each side; ascospores 4–8-
transseptate, 16–25 x 5–6 µm; norstictic and stictic acids present;
from Tamil Nadu *Graphis* sp. A
- 9a. Ascomata concolorous with the thallus.
Thallus gray, offwhite within, smooth; ascomata 0.3–7 mm long, simple
to branched, concolorous, ends acute; exciple present at the base, 2–3
striate on each side; ascospores 4–8-transseptate, 21–25 x 4–8 µm;
from Andaman Islands *G. chloroalba* Makhija & Adaw.
- 9b. Ascomata black 10
- 10a. Ascomata short, not exceeding 2 mm long.
Ascomata up to 2 mm long, simple to furcate; exciple not deeply striate,
absent at the base, 2–3 crenations at apical region; ascospores 11–13-
transseptate, 40–54 x 9–11 µm in size; from Manipur and Palni hills
. *G. rockii* Redinger
[erroneously referred to *G. striatula* (Ach.) Spreng. (Awasthi 1991)]
- 10b. Ascomata long, exceeding 2 mm long 11
- 11a. Ascomata more than 10 mm long.
Thallus yellow to olivaceous buff; ascomata 8–20 (-30) mm long, black, semi-
emergent, radiately branched; exciple present at the base, 5–6 striate on each

- side; ascospores 7–9-transseptate, 24–44 x 6–8 µm in size; from Sikkim.
 *G. sikkimensis* Nagarkar & Patw.
- 11b. Ascomata less than 10 mm long 12
- 12a. Ascospores exceeding 50 µm in length.
 Thallus olivaceous buff, gray, verruculose; ascomata 2–5 mm long, black, simple to radiately profusely branched, immersed to semi-emergent, scattered in well defined groups; exciple present at the base, 3–6 striate on each side, apically carbonized; ascospores 10–13-transseptate, 42–80 x 4–8 µm in size; from Tamil Nadu *G. olivacea*
- 12b. Ascospores not exceeding 50 µm in length. 13
- 13a. Ascomata simple.
 Thallus glaucous green to pale yellow, smooth to ferrinose; ascomata 1–3 mm long, black, semiemergent, simple, sparsely branched; strongly pruinose labia; exciple absent below, rarely not striate, mostly striate, 2–3 striate on each side; ascospores 11–13-transseptate, 40–50 x 8–10 µm; from Manipur. *G. supertexta* Müll. Arg.
- 13b. Ascomata branched 14
- 14a. Thallus gray-white; ascomata 1.5–5 (-6) mm long, black, immersed to semi-emergent, branched; exciple 2–3 striate on each side; ascospores 7–9-transseptate, 32–45 x 5–8 µm in size; from Andaman Islands, Assam, E. Himalaya and Sikkim. *G. chlorotica* A. Massal.
- 14b. Thallus grayish-yellow; ascomata 1–4 mm long, black, emergent, simple to radiately dichotomously branched, ends acute to round; exciple 2–3 internal striae, present at the base; ascospores 10–14-transseptate, 26–38 x 4–8 µm, from Manipur, Eastern & Western Himalaya *G. proserpens* Vain.
- 15a. Lichen substances present 16
- 15b. Lichen substances absent. 20
- 16a. Ascospores exceeding 50 µm in length.
 Thallus greenish gray, smooth; ascomata up to 4 mm long, concolorous with the thallus, simple, unbranched, immersed to semiemergent; exciple present below; ascospores 15–23-transseptate, 76–100 x 8–12 µm; stictic and conorstictic acids; from Karnataka *G. valparaiensis*
- 16b. Ascospores not exceeding 50 µm in length 17
- 17a. Ascomata concolorous with the thallus or whitish. 18
- 17b. Ascomata black or brownish 19
- 18a. Thallus whitish green, corticate; ascomata 0.5–2 mm long, concolorous, immersed, simple to branched, ends acute; exciple present below; ascospores 8–11-transseptate, 16–25 x 4–5 µm in size; norstictic acid present; from Karnataka. *G. alboglaucescens*
- 18b. Thallus brown, evanescent, effuse, corticate; ascomata up to 8 mm long, superficially white, prominent, simple, unbranched, rarely furcate, ends acute; exciple present below; ascospores 4–5-transseptate, 19–23 x 5–8 µm in size; constictic, stictic acids present; from Ceylon.
 *G. nematoides* Leight.

- 19a. Thallus greenish gray; ascomata 1–5 mm long, black, immersed to slightly emergent, straight to flexuose, irregularly branched; exciple not present at the base; ascospores 7–9-transseptate, 25–40 x 5–7 µm; stictic acid present; from Kerala, Tamil Nadu. *G. arecae* Vain.
- 19b. Thallus offwhite; ascomata 0.5–2 mm long, brownish, unbranched; exciple present below; ascospores 9–12-transseptate, 33–42 x 4–6 µm in size; norstictic acid present; from Karnataka. *G. eburnea*
- 20a. Ascospores not exceeding 30 µm in length.
Thallus greenish; ascomata up to 5 mm long, black, surrounded by whitish area, simple, rarely branched, acute ends, irregularly curved; exciple present at the base, plane at the apical region; ascospores 5–9-transseptate, 21–28 x 4–5 µm in size; from Tamil Nadu *G. sapii*
- 20b. Ascospores exceeding 30 µm in length 21
- 21a. Ascomata irregularly branched
Thallus ashy gray, thick; ascomata 0.5–4 mm long, concolorous with the thallus, simple to branched, thin, irregularly curved, ends acute; exciple present at the base; ascospores 8–10-transseptate, 25–38 x 6–8 µm; from Assam. *G. malacodes*
- 21b. Ascomata dendroidly/dichotomously branched 22
- 22a. Thallus whitish grey; ascomata up to 5 mm long, concolorous, immersed to semi-emergent, simple, flexuose, dendroidly branched; exciple K+ orange-red, present at the base; ascospores 7–9-transseptate, 30–40 x 6–8 µm; from Assam, Kerala & Orissa. *G. intermediella* Stirt.
- 22b. Thallus glaucous gray, rough; ascomata 1–6 mm long, concolorous, simple to dichotomously branched; exciple K-, present below; ascospores 9–11-transseptate, 38–46 x 8–10 µm in size; from Andaman Islands, Kerala and Tamil Nadu *G. glaucescens* Fée

Taxonomic descriptions

Graphis alboglaucescens Adaw. & Makhija, sp. nov.

Figure 1

MYCOBANK # MB510478

Similis *G. glaucescens* sed *acidum norsticticum continens et thallus albidus diffet*.

Etymology: from the Latin *albidus*, whitish and from the species name *glaucescens*.

Holotype—India, Karnataka, Nandi hills, 26.9.1981, P.K. Sethy & M.B. Nagarkar, 81.578; **holotype**:AMH.

Thallus whitish green, smooth, distinctly cracked, delimited by a thin black hypothallus. **Ascomata** lirelline, 0.5–2 mm long and 0.1–0.2 mm broad, simple to branched, irregularly curved, concolorous with the thallus, immersed, thin, scattered, narrow, acute ends. **Disc** black, narrow, covered by white pruina. **Thalline margin** concolorous with the thallus, separated from the exciple by a fine crack. **Exciple** yellowish, complete, present at the base, convergent, covered by a thalline margin up to the top, without striations, apically carbonized.

Epithecium pale yellow, thin. **Hymenium** hyaline, not inspersed, 86–90 μm high and 140–145 μm broad, I-, KI-. **Hypothecium** hyaline, 6–8 μm thick. **Paraphyses** simple, long, thin, filiform. **Asci** 8 sporate. **Ascospores** 8–11-transseptate, ellipsoidal, 16–25 x 4–5 μm , I+ blue.

Chemistry — Norstictic acid present.

Remarks — *Graphis alboglaucescens* is closely related to *Graphis glaucescens* (syn. *G. bulcana* Vain.) with respect to external morphology. According to Lücking (pers. comm.2006), *G. glaucescens* has an entire striate excipulum, the thallus is ecorticate, glaucous gray and lacks lichen substances. The species is somewhat comparable to *G. kakaduensis* A.W. Archer from Australia and the pantropical *G. caesiella* in having small transversely septate ascospores and norstictic acid; however, the exciples are laterally carbonized in *G. kakaduensis*, and *G. caesiella*. *G. alboglaucescens* can easily be distinguished from *G. stipitata* A.W. Archer by the additional presence of lichexanthone and the laterally carbonized excipulum in that species. *G. immersella* can also be distinguished from the present species in having stictic acid and a laterally carbonized excipulum. *G. alboglaucescens* can be distinguished from the closely related new species *G. eburnea* (in the present paper) by its small ascospores. *G. eburnea* has larger ascospores of 33–42 x 4–6 μm .

The species was collected on a roadside tree in the dry deciduous forests of Karnataka.

Graphis cf. bakeri Vain. Ann. Acad. Sci. Fenn. Ser. A., 15(6): 253, 1921. Figure 2

Thallus yellowish to whitish gray, smooth, cracked, unevenly thickened, delimited by thin black hypothallus. **Ascomata** lirelline, 0.5–5 mm long, dichotomously to irregularly branched, black, scattered, slightly raised, acute to obtuse ends. **Disc** narrow, blackish brown, pruinose. **Exciple** complete, indistinct at the base to sometimes absent at the base, convergent, covered by a thalline exciple to the top, not striate, laterally carbonized. **Epithecium** indistinct. **Hymenium** hyaline, not inspersed, 90–120 μm high and 121–150 μm broad, I-, KI-. **Hypothecium** thin, hyaline to pale yellowish orange. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 9–12-transseptate, ellipsoidal, 42–46 x 3–4 μm , I+ blue.

Chemistry — Salazinic acid present.

SPECIMENS EXAMINED—INDIA. ANDAMAN ISLANDS: South Andaman, Nilambur forest, Baratang, Forest guest house, P.G. Patwardhan & M.B. Nagarkar 85.367; HIMACHAL PRADESH: Kalatop, above Dharmashala, P.G. Patwardhan 70.726, Khajjiar, above Chamba, P.G. Patwardhan 70.739; KERALA: Shabrimalai hills, Patnamthatta, U.V. Makhija & P.G. Patwardhn 83.490, 83.497, 83.517 (AMH).

Remarks — The present species seems to be most similar to *G. bakeri* except the slightly smaller ascospores in *G. bakeri*.

***Graphis eburnea* Adaw. & Makhija, sp. nov.**

Figure 3

MycoBank # MB 510479

*Similis G. desquamescenti sed excipulo apicibus striatus et hymenium non inspersus.**Etymology:* from the Latin *eburnea*, white with yellow tinge; a reference to the off-white thallus.**Holotype**—India, Karnataka, Anamod Ghat, 21.10.1970, P.G. Patwardhan & P.D. Badhe, 70.70; **holotype**:AMH.

Thallus offwhite, smooth, thin, delimited by thin black hypothallus. **Ascomata** lirelline, 0.5–2 mm long and 0.1–0.25 mm broad, simple, brownish black, scattered, slightly raised above the thallus, narrow, acute ends. **Disc** narrow to slightly broad, blackish brown. **Exciple** complete, present below, convergent, covered by a thalline exciple to the top, not striate, apically carbonized. **Epithecium** thin, pale brown, K-. **Hymenium** hyaline, not inspersed, 80–84 µm high and 138–147 µm broad, I-, KI-. **Hypothecium** hyaline, 6–8 µm thick. **Paraphyses** simple, long, thick, globose at the tip, unbranched. **Asci** 8 sporate. **Ascospores** 9–12-transseptate, ellipsoidal, 33–42 x 4–6 µm, I+ blue.

Chemistry — Norstictic acid present.

Remarks — *Graphis eburnea* resembles *G. desquamescens* Fée. Both species have an off-white thallus and contain norstictic acid, but the exciple is completely carbonized in *G. desquamescens* and the hymenium is inspersed. *G. vinosa* Müll. Arg., also resembles the new species but is distinguished by the laterally carbonized exciple and slightly larger ascospores, 40–50 µm long. The species can also be compared with *G. vittata* in overall morphology but it is differentiated from the present species in having stictic acid only.

***Graphis filiformis* Adaw. & Makhija, sp. nov.**

Figure 4

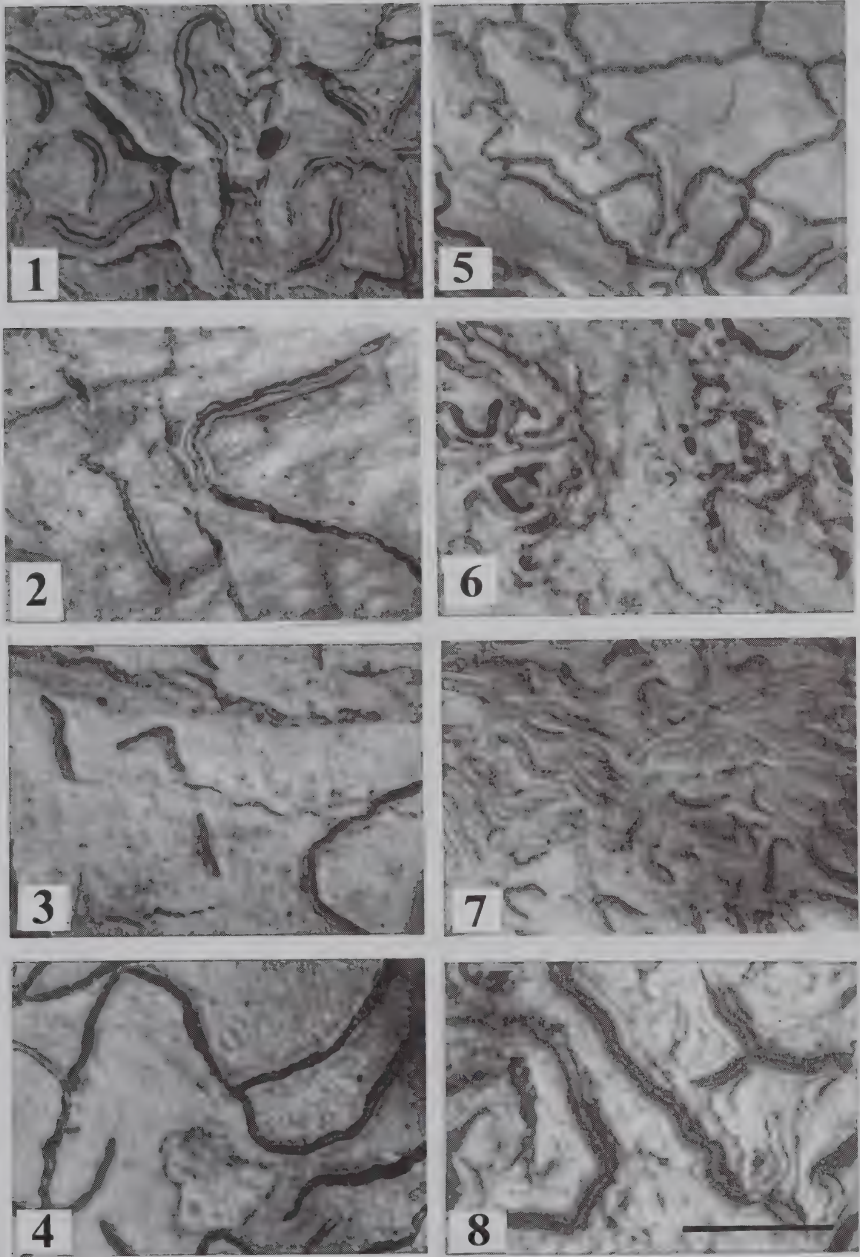
MycoBank # MB 510480

*Similis G. intricatae sed lirellis longioribus et ascosporis minoribus differt.**Etymology:* from the Latin *filiformis*, thread like; a reference to thin, slender, thread like lirellae.**Holotype**—India, Karnataka, Jog Falls, 1.11.1971, D.N. Mhaskar, 71.54; **holotype**:AMH.

Thallus whitish brown, smooth, delimited by thin black hypothallus. **Ascomata** distinct, black, few in number, irregularly curved, thin, slender, thread like, more than 10 mm long, simple to branched, ends acute. **Disc** narrow to moderately broad, black. **Exciple** not striate, present at the base, convergent, laterally carbonized. **Epithecium** indistinct, sometimes pale brownish. **Hymenium** hyaline, not inspersed, 80–90 µm high and 100–130 µm broad, I-, KI-. **Asci** 8 sporate. **Ascospores** 7–9-transseptate, 21–25 x 6–8 µm, I+ blue.

Chemistry — Norstictic, connorstictic acids present.

Remarks — *Graphis intricata* Fée somewhat resembles the new species *G. filiformis* in internal morphology, however, *G. intricata* has a basally carbonized



Figures—1-8. Habit 1. *Graphis alboglaucescens*, 2. *G. cf. bakeri*, 3. *G. eburnea*, 4. *G. filiformis*, 5. *G. furcata*, 6. *G. immersella*, 7. *G. malacodes*, 8.. *G. meghalayaensis*. Bar = 2mm

excipulum. *G. pyrrhocheiloides* is another species close to *G. filiformis* in respect of morphology and chemistry, however, *G. pyrrhocheiloides* has larger ascospores of 40–46 x 8–12 µm in size.

The species was collected in moist deciduous forests along waterfalls.

Graphis furcata Fée Essai Cryptog. Ecorc. Officin., 40, 1824.

Figure 5

Thallus whitish gray, pale yellowish, rough to smooth, unevenly thickened, warty, cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 1–7 mm long and *ca.* 0.1–0.25 mm broad, scattered, simple, dendroidly or irregularly branched, black, irregular, acute to round ends. **Disc** narrow, blackish brown to black. **Exciple** present at the base, convergent apically, covered by a thalline margin up to the top, not striate, laterally carbonized. **Epithecium** pale brown, thin. **Hymenium** hyaline, not interspersed, 63–84 µm high and 105–126 µm broad, I-, KI-. **Hypothecium** hyaline, 4–6 µm thick. **Paraphyses** simple, long, thin, filiform, septate. **Asci** cylindrical, 8 spore. **Ascospores** 5–7-transseptate, ellipsoidal, 21–25 x 4–5 µm, I+ blue.

Chemistry — no lichen substance present.

SPECIMENS EXAMINED—INDIA. ANDAMAN ISLANDS: Middle Andaman, Betapur Range, Dhaninala, M.B. Nagarkar & P.G. Patwardhan 85.2529. ASSAM: Balapara, P.G. Patwardhan & M.B. Nagarkar 77.1236 P.G. Patwardhan & M.B. Nagarkar, 85.2027 (AMH).

Remarks — *Graphis furcata* apparently resembles *G. tenella* from which it differs in having narrower, wavy ascomata with entire exciple. The type material of *G. tenella* at Helsinki has striate labia (Wirth & Hale 1978). The species is known from the tropical regions of the world and now being reported for the first time from India. The species is found to be associated with member of *Arthoniaceae*.

Graphis immersella. Müll. Arg. Bull. Herb. Boiss. 3: 319, 1895.

Figure 6

Thallus yellowish rugose, unevenly thickened, delimited by thin black hypothallus. **Ascomata** lirelline, 1–4 mm long, 0.1–0.3 mm broad, simple to branched, black, scattered, immersed, with acute to obtuse ends. **Disc** moderately broad, 0.1–0.2 mm broad, blackish brown. **Exciple** complete, present below, convergent, covered by a thalline exciple to the top, narrow at the base and expanded at the apical region, entire, laterally carbonized. **Epithecium** thin, hyaline, K-. **Hymenium** hyaline, not interspersed, 37–50 µm high and 105–168 µm broad, I-, KI-. **Hypothecium** thin, hyaline. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 spore. **Ascospores** 5–7-transseptate, ellipsoidal, 16–25 x 3–4 µm, I+ blue.

Chemistry — Stictic and constictic acids present.

SPECIMEN EXAMINED—INDIA. ANDAMAN ISLANDS: North Andaman, Mayabander Range, Interview Island, P.K. Sethy & P.G. Patwardhan 85.2871 (AMH).

Remarks — The species was earlier known from Australia and is now being reported for the first time from India.

Graphis malacodes Nyl. Bull. Soc. Linn. Norm. ser. 2, 2 : 116, 1868.

Figure 7

Thallus ashy gray, thick, uneven, cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 0.5–4 mm long and 0.1 mm broad, simple to branched, thin, irregularly curved, concolorous with the thallus, immersed to slightly raised by the thalline margin, separated from the thallus by a crack, thin, crowded, narrow, acute ends. **Disc** narrow, slit like, black, covered by white pruina. **Exciple** complete, present below, convergent, covered by a thalline exciple to the top, not striate, apically carbonized. **Epithecium** thin, hyaline, K-. **Hymenium** hyaline, not interspersed, 97–105 μ m high and 185–189 μ m broad, I-, KI-. **Hypothecium** orange brown, 16–21 μ m thick. **Paraphyses** simple, long, thick, globose at the tip, unbranched. **Asci** 8 sporate. **Ascospores** 8–10-transseptate, ellipsoidal, 25–38 x 6–8 μ m, I+ blue.

Chemistry — no lichen substances present.

SPECIMEN EXAMINED—INDIA. ASSAM: Maniknagar, P.G. Patwardhan 77.1198, P.G. Patwardhan & M.B. Nagarkar, 77.1194 (AMH).

Remarks — The species is being reported for the first time from India.

Graphis meghalayaensis Adaw. & Makhija, sp. nov.

Figure 8

Mycobank # MB 510481

Similis *G. nigroglaucæ* sed *ascosporis majoribus differt*.

Etymology: from the Latin *ensis*, a place of origin, and Meghalaya, the type locality.

Holotype—India, Meghalaya, Wiloe, 30.10.1977, P.G. Patwardhan & M.B. Nagarkar, 77.1115; holotype:AMH.

Thallus olivaceous, rough, thin, warty. **Ascomata** lirelline, 0.5–6 mm long, mostly simple to rarely branched, concolorous with the thallus, scattered, semi-emergent, acute to obtuse ends. **Disc** narrow, black, epruinose. **Exciple** complete, present below, convergent, spreading at the apical region, covered by a thalline exciple till top, multistriate, striae not separated from each other, apically carbonized. **Epithecium** thin, hyaline, K-. **Hymenium** hyaline, not interspersed, 60–75 μ m high and 80–90 μ m broad, I-, KI-. **Hypothecium** thin, pale orange. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 24–30-transseptate, long, ellipsoidal, 84–93 x 5–7 μ m, I+ blue.

Chemistry — Norstictic, and stictic acids present.

Remarks — The new species *Graphis meghalayaensis* resembles *G. nigroglaucæ* Leight. which, however, differs from the present taxon by the smaller ascospores of 30–50 x 6–10 μ m in that species.

Graphis olivacea Redinger Ark. Bot. 27(A): 55, 1935.

Figure 9

Thallus olivaceous buff, gray, rough, thick, minutely cracked, verruculose, epruinose. **Ascomata** lirelline, 2–5 mm long and 0.2–0.5 mm broad, simple to radiately branched, distinctly black, immersed to semiemergent, scattered in well defined groups, narrow, acute ends. **Disc** narrow, covered by white pruina. **Exciple** complete, present at the base, convergent, covered by a thick thalline margin to the top, striate, 3–6 striae on each side, apically carbonized, expanded at the apical region. **Epithecium** hyaline, thin. **Hymenium** hyaline, not interspersed, 90–120 μm high and 130–160 μm broad, I-, KI-. **Hypothecium** indistinct. **Paraphyses** simple, long, thin, filiform, septate. **Asci** cylindrical, 8 sporate. **Ascospores** 10–13-transseptate, ellipsoidal, 42–80 x 4–8 μm , I+ blue.

Chemistry — no lichen substances present.

SPECIMENS EXAMINED—INDIA. TAMIL NADU: Kollaimalai, P.G. Patwardhan 85.1721, 85.1732 (AMH).

Graphis rigidula Müll. Arg. Bull. Soc. Roy. Bot. Belgique 30: 78, 1891. Figure 10

Thallus buff to off white, smooth, thin, finely cracked. **Ascomata** lirelline, 3–5 mm long and 0.1–0.2 mm broad, simple to irregularly branched, scattered, black, immersed to slightly raised above the thallus, thin, acute ends. **Disc** light brown, narrow to slightly broad, covered by white pruina. **Exciple** not striate to sometimes rarely striate, 1–2 striae on each side, present at the base, convergent, covered by a thalline margin to the top, laterally carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not interspersed, 70–105 μm high and 112–175 μm broad, I-, KI-. **Hypothecium** yellowish to pale orange, 10–15 μm thick. **Paraphyses** simple, long, thin, filiform. **Asci** cylindrical, 6–8 sporate. **Ascospores** 7–15-transseptate, ellipsoidal, 25–56 x 8–12 μm , I+ blue.

Chemistry — no lichen substances present.

SPECIMEN EXAMINED—INDIA. TAMIL NADU: Kodaikanal, P.G. Patwardhan & M.B. Nagarkar 73.1847 (AMH).

Remarks — *Graphis rigidula* is morphologically similar to *G. longula* Kremp., but *G. longula* has sunken ascomata, is laterally carbonized and has larger ascospores (40-)70–90 x 9–13 μm . This is a new record for India. The species was previously known from Costa Rica, and Dominica

Graphis salacinilongiramea Adaw. & Makhija, sp. nov.

Figure 11

Mycobank # MB 510482

Similis G. longirameae sed acida salazinicum, sticticum, hyposticticum, et hypoconsticticum continens differt.

Etymology: from the species name *longiramea* and salazinic acid contents.

Holotype—India, Karnataka, Sringeri, 6 km from Sringeri-Balehonur Road, 17.12.1974, C.R. Kulkarni & A.V. Prabhu, 74.3180; holotype: AMH.

Thallus glaucous green, grayish to pale brown, smooth, thick, tightly attached to substratum, delimited by black hypothallus. **Ascomata** lirelline, 5–12 mm long and 0.1–0.3 mm broad, simple to radiately dichotomously branched, stellate, immersed to semiemergent, scattered all over the thallus, black, acute to obtuse ends. **Disc** narrow black, epruinose. **Exciple** not striate, present at the base, and converging at the apical portion, covered by a thick thalline margin up to the top, laterally carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, 110–150 μm high and 180–220 μm broad, I-, KI-. **Hypothecium** hyaline, 10–12 μm thick. **Paraphyses** simple, long, thin, filiform, septate, thickened at the tips. **Asci** cylindrical, 8 sporate. **Ascospores** fusiform-oblong, 8–16-transseptate, 45–87 x 9–10 μm , I+ blue.

Chemistry — Salazinic (major), Stictic acid (major), hypoconstictic and hyposalazinic acids present.

SPECIMENS EXAMINED—INDIA. KARNATAKA: South Canara, Balehonur to Sringeri Road, C.R. Kulkarni 74.3188, 74.3204; P.G. Patwardhan & M.B. Nagarkar 74.3205, 74.3235 74.3607; Talcauvar, Coorg, M.B. Nagarkar & A.V. Prabhu 74.3353 (AMH).

Remarks — *Graphis salacinilongiramea* is very similar to *Graphis longiramea* in all respects, however, it contains salazincic acid, hypostictic and hyposalazinic acid in addition to stictic acid and therefore described as a separate species. The new species is also comparable with *G. arecae* regarding its morphology and chemistry but that species differs in having smaller ascospores of 25–40 x 5–7 μm .

Graphis sapii Zahlbr. Symbol. Sinic., Pars 3: 39–40, 1930.

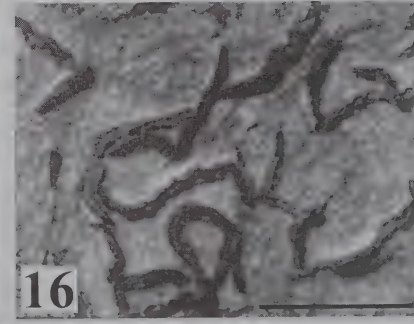
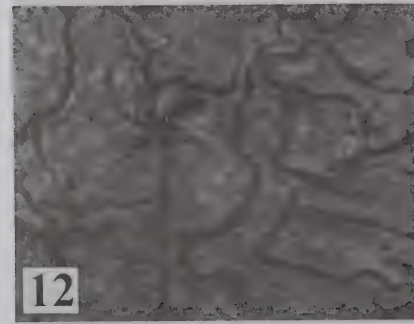
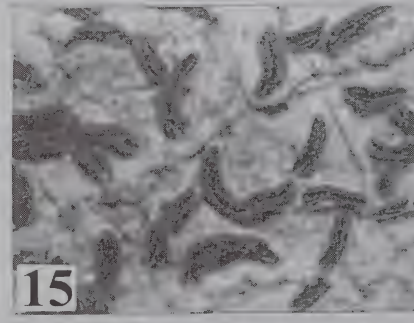
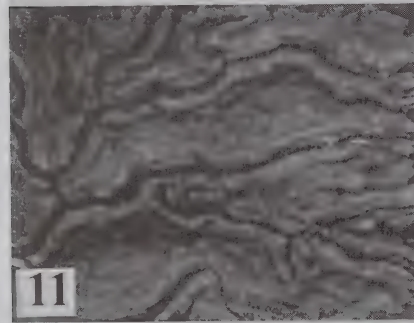
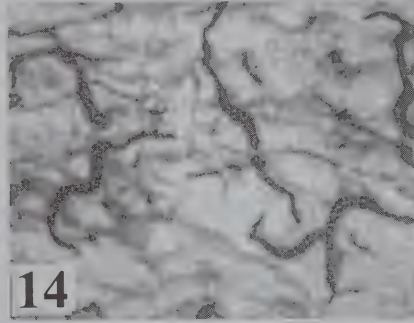
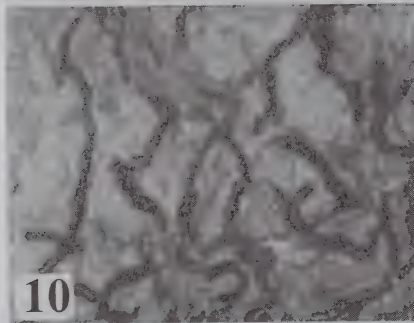
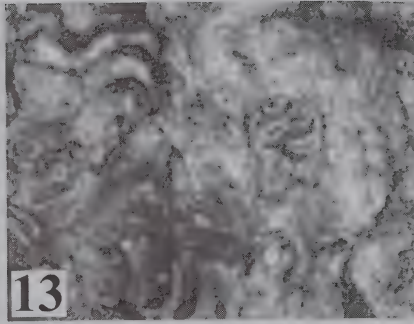
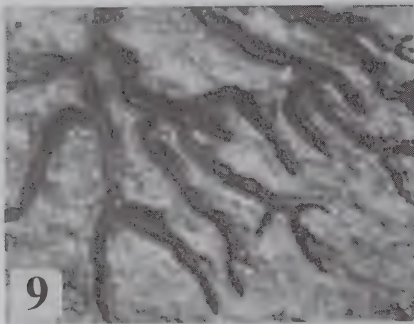
Figure 12

Thallus greenish gray, thick, uneven, distinctly cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 0.5–5 mm long and 0.1–0.2 mm broad, mostly simple to rarely branched, thin, irregularly curved, black, immersed, thin, scattered, narrow, separated by distinct fine cracks, acute ends. **Disc** brown, narrow, epruinose. **Exciple** orange yellow, plane at the apical region, complete or indistinctly present at the base, convergent, covered by a thalline margin up to the top, not striate, apically carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not interspersed, 75–84 μm high and 92–105 μm broad, I-, KI-. **Hypothecium** hyaline, 6–7 μm thick. **Paraphyses** simple, long, thin, filiform. **Asci** cylindrical, 8 sporate. **Ascospores** 5–9-transseptate, ellipsoidal, 21–28 x 4–5 μm , I+ blue.

Chemistry — no lichen substances present.

SPECIMENS EXAMINED—INDIA. TAMIL NADU: Upper Kodayar, on the way to Kakachi, elev. approx. 1400 m., P.G. Patwardhan 84.133 (AMH).

Remarks — The most closely related species are *Graphis glaucescens* and *G. chlorotica* from Amboina, also having the exciple carbonized only at the tip and the thallus without lichen substances. They differ from the present species



especially in having larger ascospores. In *G. glaucescens* ascospores are of $38\text{--}45 \times 8\text{--}10 \mu\text{m}$ and in *G. chlorotica* $33\text{--}45 \times 5\text{--}8 \mu\text{m}$. The specimen was collected on the road side tree in undisturbed forest at higher elevation. The species is earlier known from China and now being reported for the first time from India.

Graphis schiffneri Zahlbr. Ann. Cryptog. Exot. 1: 127, 1928.

Figure 13

Thallus greenish, rough, uneven, thick, epruinose, delimited by thin black hypothallus. **Ascomata** lirelline, $0.5\text{--}1.5 \text{ mm}$ long and $0.1\text{--}0.2 \text{ mm}$ broad, simple to branched, immersed, curved, flexuose, scattered all over the thallus, ends acute to obtuse. **Disc** narrow, black, covered by white pruina. **Exciple** complete, present at the base, without striae or sometimes 2 striae seen on each side, convergent, laterally carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not interspersed, $90\text{--}110 \mu\text{m}$ high and $100\text{--}120 \mu\text{m}$ broad, K-. KI-. **Hypothecium** orange broad, $4\text{--}6 \mu\text{m}$ thick. **Paraphyses** simple, long, thin, filiform, septe, thickened at the apices. **Asci** cylindrical, 8 sporate. **Ascospores** ellipsoidal, $5\text{--}7\text{-transseptate}$, $17\text{--}25 \times 3\text{--}4 \mu\text{m}$, I+ blue.

Chemistry — norstictic acid present.

SPECIMEN EXAMINED—INDIA. KERALA: Paranthal, near Changaneshi-Trivandrum road, C.R. Kulkarni 76.884 (AMH).

Remarks — the most closely *G. exalbata* Nyl. differs from the present species only in having saxicolous thallus. The species is known from North West Himalaya of India.

Graphis stenotera Vain. Ann. Acad. Sci. Fenn., Ser. A. 15(6): 243, 1921. Figure 14

Thallus off white, yellowish to stramineous, thin, rough, uneven, sometimes evanescent, delimited by thin black hypothallus. **Ascomata** lirelline, $0.5\text{--}6 \text{ mm}$ long and $0.1\text{--}0.2 \text{ mm}$ broad, mostly simple to occasionally branched, thin, irregularly curved, black, narrow, semi-emergent, acute ends. **Disc** black, narrow, epruinose. **Exciple** complete, present at the base, convergent, covered by a thalline margin up to the top, striate, $5\text{--}6$ striae on each side, apically carbonized, carbonization extending laterally on the outer striae and does not border hymenium, inner part reddish orange. **Epithecium** indistinct. **Hymenium** hyaline, not interspersed, $54\text{--}63 \mu\text{m}$ high and $84\text{--}96 \mu\text{m}$ broad, I-, KI-. **Hypothecium** hyaline, $6\text{--}8 \mu\text{m}$ thick. **Paraphyses** simple, long, thin, filiform, septate. **Asci** cylindrical, 8 sporate, **Ascospores** $5\text{--}9\text{-transseptate}$, ellipsoidal, $21\text{--}38 \times 4\text{--}6 \mu\text{m}$, I+ blue.

Chemistry — stictic acid (major) and constictic acid (trace) present.

Figures—9–16. Habit 9. *G. olivacea*, 10. *G. rigidula*, 11. *G. salacinilongiramea*, 12. *G. sapii*, 13. *G. schiffneri*, 14. *G. stenotera*, 15. *G. subvittata*, 16. *G. urandreae*. Bar = 2mm

SPECIMENS EXAMINED—INDIA. KARNATAKA: Kemmengundi, U.V. Makhija & S.P. Kekre 82.467; Silent Valley, M.B. Nagarkar 81.776, P.G. Patwardhan M.B. Nagarkar 82.19. KERALA: Wyanad, M.B. Nagarkar 76.61; Anamalai hills, Valparai forest, M.B. Nagarkar 76.405; Upper Kodayar, P.G. Patwardhan 83.344. TAMIL NADU: Nandi hills, M.B. Nagarkar P.K. Sethy 81.480 (AMH).

Remarks — *Graphis stenotera* is distinguished by its off white to stramineous thallus; black, mostly simple to occasionally branched long lirellae; striate and laterally carbonized exciples and presence of stictic and constictic acids in the thallus.

The species was previously reported from Philippines and now reported for the first time from India.

***Graphis subvittata* Adaw. & Makhija, sp. nov.**

Figure 15

Mycobank # MB 510483

Similis G. vittatae sed acida sticticum, consticticum continens differt.

Etymology: from the Latin *sub*, somewhat, almost and the epithet *vittata*, a reference to the similarity with *Graphis*.

Holotype— India, Karnataka, Nandi hills, 26.9.1981, M.B. Nagarkar & P.K. Sethy, 81.508; holotype: AMH.

Thallus cream whitish, rough, cracked, uneven, delimited by black hypothallus. **Ascomata** lirelline, 0.2–2 mm long, emergent, simple, black, distinctly raised above, scattered, round ends. **Disc** narrow, not visible. **Exciple** complete, present at the base, convergent, covered by a thalline margin till the top, striate, 3–4 striae on each side, apically to laterally carbonized. **Epithecium** indistinct. **Hymenium** hyaline, not interspersed, 92–105 µm high and 126–147 µm broad, I-, KI-. **Hypothecium** hyaline to light orange yellow. **Paraphyses** simple, long, thin, filiform, septate. **Asci** cylindrical, 8 spore. **Ascospores** 8–11-transseptate, ellipsoidal, 25–29 (–33) x 4–5 µm, I+ blue.

Chemistry — stictic (major), constictic and norstictic (major) acids present.

Remarks — *Graphis subvittata* is characterized by conspicuous, black, emergent lirellae; 3–4 striate, apically carbonized exciple and constictic, norstictic and stictic acids. This new species is distinguished from *G. vittata* especially by the presence of norstictic acid in the thallus. *Graphis subvittata* can also be compared with *G. nigroglaucua* having striate, apically carbonized exciple, chemistry norstictic and stictic acid, however, differs from the present species in having large ascospores of the size (–28) 39–57 x 5–7 µm, and the absence of constictic acid.

***Graphis urandrae* Vain. Ann. Acad. Sci. Fenn. Ser. A. 15(6): 255, 1921.** **Figure 16**

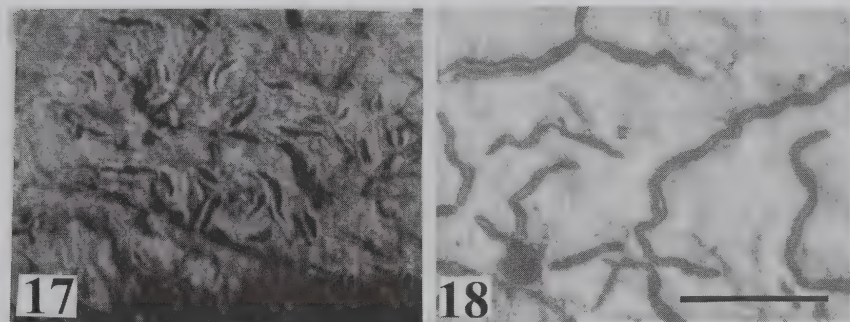
Thallus grayish green, rough, unevenly thickened to distinctly verrucose, distinctly cracked. **Ascomata** lirelline, 3–5 mm long, 0.1–0.2 mm broad, black, simple to branched, emergent, round ends. **Disc** black, narrow. **Exciple** complete,

present at the base, convergent, covered by a thalline margin to the top, entire, laterally carbonized. **Epithecium** distinct pale brown, thin. **Hymenium** hyaline to brownish tinged, not inspersed, 130–140 μm high and 168–315 μm broad, I-, KI-. **Hypothecium** hyaline, thin. **Paraphyses** simple, long, thin. **Asci** 8 sporate. **Ascospores** 3–6-transseptate, ellipsoidal, 21–34 x 4–5 μm , I + blue.

Chemistry — no lichen substances.

SPECIMENS EXAMINED—INDIA. ANDAMAN ISLANDS: North Andaman, Diglipur Range, Sitapur M.B. Nagarkar & P.G. Patwardhan 86.196; P.K. Sethy & M.B. Nagarkar 86.197, 86.232; SIKKIM: Gangtok, near Tangshi View Point, P.G. Patwardhan & M.B. Nagarkar 77.1953, 77.1963 (AMH).

Remarks — *Graphis urandrae*, a very distinct species, is here reported for the first time from India. The species was collected in association with *Physcia* and other graphids in the tropical rain forests of the Andaman Islands. The species was previously known from the Philippines.



Figures—17-18. Habit. 17. *G. valparaiensis*, 18. *G. sp. A*.

Bar = 2mm

Graphis valparaiensis Adaw. & Makhija, sp. nov.

Mycobank # MB 510484

Figure 17

Similis G. olivaceae sed excipulo non striato et acidum sticticum continens differt.

Etymology: From the Latin *ensis*, a place of origin, and Valparai the type locality.

Holotype—India, Tamil Nadu: Anamalai hills, on the way to Valparai, 200 ft., 3.1.1982, P.G. Patwardhan & M.B. Nagarkar, 82.262; holotype: AMH.

Thallus greenish-gray, distinctly cracked, thick, delimited by thin, black hypothallus. **Ascomata** lirelline, 0.5–4 mm long and 0.1–0.2 mm broad, mostly simple to occasionally branched, concolorous with the thallus, scattered, immersed, narrow, acute ends. **Disc** narrow, black, epruinose. **Exciple** yellowish, complete, present below, convergent, covered by a thalline exciple till top, entire, apically carbonized. **Epithecium** thin, hyaline. **Hymenium** hyaline, not inspersed, 126–189 μm high and 168–210 μm broad, I-, KI-. **Hypothecium** pale brown, 8–12 μm high. **Paraphyses** simple, long, unbranched. **Asci** 8 sporate,

110–125 x 10–14 μm . **Ascospores** hyaline, 15–23-transseptate, ellipsoidal, 76–100 x 8–12 μm , I+ blue.

Chemistry — stictic, con-norstictic acids present.

Remarks — *Graphis valparaiensis* is distinguished by its apically carbonized exciple, large ascospores of 76–100 x 8–12 μm and presence of stictic and connorstictic acids in its thallus. *G. valparaiensis* is somewhat close to *G. olivacea* and *G. meghalayaensis*, a new species described here with large ascospores of the size (–45) 60–90 (–125) x 8–10 μm and 84–93 x 3–4 μm , however *G. olivacea* has a striate, apically carbonized exciple and *G. meghalayaensis* has a striate exciple and norstictic acid.

Graphis sp. A

Figure 18

Thallus grayish, pale green to gray, yellow within or offwhite, smooth, cracked, delimited by black hypothallus. **Ascomata** lirelline, 0.3–9 mm long and 0.2 mm broad, black, simple, curved, scattered, immersed to slightly emergent, separated from the thallus with a narrow fissure, irregular, flexuose, acute ends. **Disc** narrow barely visible, blackish brown to black. **Exciple** complete, present at the base, convergent, covered by a thalline margin up to the top, striate, 2–3 striae on each side, apially carbonized, studded with crystals between striae. **Epithecium** pale, thin. **Hymenium** hyaline, not inspersed, 84–109 μm high and 117–134 μm broad, I-, KI-. **Hypothecium** yellow, 6–8 μm high. **Paraphyses** simple, long, thin. **Asci** 6–8 sporate. **Ascospores** 4–8-transseptate, ellipsoidal, 16–25 x 5–6 μm , I+ blue.

Chemistry — norstictic and stictic acids present.

SPECIMEN EXAMINED—INDIA. TAMIL NADU: Kodaikanal, near Daisy Bank, P.G. Patwardhan & C.R. Kulkarni 75.337 (AMH).

Remarks — The present species somewhat resembles *Graphis longula* and *G. persulcata* Stirt. in having striate exciple. *G. longula*, however, has much longer ascospores of 70–90 μm and has no lichen substances and *G. persulcata* has laterally carbonized exciple. On account of the insufficient material this species has not been described formally and has been kept unnamed for the time being.

Acknowledgments

We are thankful to Dr. R. Lücking (Field Museum, Chicago) and Dr. A.W. Archer, National Herbarium of New South Wales, Australia for providing valuable comments on this manuscript. We are grateful to the Department of Science and Technology, New Delhi, India and Ministry of Environment and Forests, New Delhi, India, for the financial support.

Literature Cited

- Adawadkar B, Makhija U. 2004. A new isidiate species of lichen genus *Graphis* from India. *Lichenologist* **36**(6): 361-363.
- Adawadkar B, Makhija U. 2005. Some transseptate species of the genera *Hemithecium* and *Platythecium* from India. *Mycotaxon* **92**: 387-394.
- Adawadkar B, Makhija, U. 2006. New species and new records of *Graphis* from India: transseptate species with completely carbonized exciples and norstictic acid. *Mycotaxon* **96**: 51-60.
- Archer AW. 1999. The lichen genera *Graphis* and *Graphina* (*Graphidaceae*) in Australia 1. Species based on Australian type specimens. *Telopea* **8**(2): 273-295.
- Archer AW. 2001a. New taxa and new reports in the lichen family *Graphidaceae* (Ascomycotina) from Australia. *Mycotaxon* **80**: 367-374.
- Archer AW. 2001b. The lichen genus *Graphina* (*Graphidaceae*) in Australia: New reports and new species. *Mycotaxon* **77**: 153-180.
- Archer AW. 2001c. The lichen genus *Graphis* (*Graphidaceae*) in Australia. *Australian Systematic Botany* **14**: 245-271.
- Archer AW. 2004. Additions to the lichen flora of Fiji and Vanuata based on *Graphidaceae* in the F.R.M. Wilson collection at the National Herbarium of New South Wales. *Telopea* **10**(4): 771-776.
- Awasthi DD. 1991. A key to the Microlichens of India, Nepal and Sri Lanka. *Bibliotheca Lichenologica* **40**: 1-337.
- Awasthi DD. 2000. Lichenology in Indian Subcontinent. Bishen Singh Mahendra Pal Singh, Dehradun, Pp. 1-124.
- Awasthi DD, Singh KP. 1972. Four new taxa of lichens from Palni and Nilgiri hills, India. *Nordic Journal of Botany* **19**: 239-242.
- Awasthi DD, Singh KP. 1975. Observation on some Graphidaceous lichen taxa. *Phyta* **1**: 34-40.
- Awasthi DD, Singh SR. 1977. Five new taxa of saxicolous lichens from Meghalaya, India. *Norw. J. Bot.* **24**: 1-8.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. *J. Chromatogr.* **72**: 113-125.
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* **46**: 85-93.
- Kirk PM, Canon PF, David JC, Stalpers JA (eds.) 2001. Dictionary of the fungi 9th edition. CABI International, UK. Pp. 1-655.
- Kulkarni CR. 1977. A new species of *Graphis* from Western Ghats, South Western India. *Biovigyanam* **3**: 115-116.
- Leighton WA. 1869. The lichens of Ceylon collected by G.H.K. Thwaites. *Trans. Linn. Soc. London* **27**: 161-186.
- Makhija U, Adawadkar B. 2003. A new species of *Acanthothecis* from India. *Mycotaxon* **88**: 139-141.
- Makhija U, Adawadkar B. 2005a. Some additions to the *Graphidaceae* in the Andaman islands, India. *Mycotaxon* **91**: 347-352.
- Makhija U, Adawadkar B. 2005b. Some new species of *Graphis* (Lichenised Ascomycota) from the Andaman and Nicobar Islands of India. *Mycotaxon* **91**: 369-379.
- Makhija U, Kekare S, Patwardhan PG. 1992a. Materials for a lichen flora of the Andaman Islands: VII-The family *Graphidaceae*. *Biovigyanam* **18**(1): 12-20.
- Makhija U, Adawadkar B, Patwardhan PG. 1992b. Materials for a lichen flora of the Andaman Islands: VIII-The genus *Graphina*. *Biovigyanam* **18**(1): 21-32.

- Makhija U, Dube A, Adawadkar B, Chitale GC. 2005a. Some species of Lichen genera *Dyplolabia* and *Graphis* from Maharashtra, India. *Geophytology* (in press).
- Makhija U, Dube A, Adawadkar B, Chitale GC. 2005b Five trans-septate species of *Hemitecium* from India. *Mycotaxon*, **93**: 365-372.
- Müller Arg., J. 1880 Lichenologische Beiträge X. *Flora* **63**: 40-45.
- Müller Arg., J. 1882. Lichenologische Beiträge XV. *Flora* **65**: 381-386.
- Nagarkar, MB, Patwardhan, PG. 1982. Notes on some lichens from North East India IV: Genus *Graphis*. *Biovigyanam* **8**: 125-131.
- Nakanishi M. 1966. Taxonomical studies on the Family *Graphidaceae* of Japan. *Journal of Science of the Hiroshima University, Series B, Div. 2*, **11**: 51-126.
- Nakanishi M. Harada H. 1999. Five new species of the lichen genus *Graphis* (Lichenized Ascomycota, *Graphidaceae*) from the Mariana Islands, Micronesia. *Natural History Resources* **5**(2):63-71.
- Nakanishi M, Kashiwadani H., Moon KH. 2001. Notes on the Genera *Graphina* and *Graphis* (*Graphidaceae*) in Thailand. *Bulletin of the National Science Museum, Tokyo, Ser. B*, **27**(2,3): 47-55.
- Nakanishi M, Kashiwadani H, Moon, KH. 2002. New species of *Graphis*, *Phaeographina* and *Sarcographa* (Ascomycotina, *Graphidaceae*) from Vanuatu. *Bulletin of the National Science Museum* , Tokyo, Ser,B, **28**(4):107-111.
- Nakanishi M, Kashiwadani H, Moon KH. 2003. Taxonomical notes on Japanese *Graphidaceae* (Ascomycotina), including some new combinations. *Bulletin of the National Science Museum, Tokyo, Ser. B*, **29**(2): 83-90.
- Patwardhan PG, Kulkarni CR. 1976. Some additions to the lichen flora of India IV: *Graphis* and *Graphina* (Family *Graphidaceae*). *Biovigyanam* **2**: 123-132.
- Patwardhan PG, Kulkarni CR. 1979. Some new taxa of the family *Graphidaceae* from Western Ghats, Southwestern India. *Norw. J. Bot.* **26**: 45-52.
- Redinger K. 1935. Die Graphidineen der ersten Regnell'schen Expedition nah Brasilien 1892-1894. III *Graphis*, *Phaeographis*, nebst einem Nachtrage zu *Arkiv för Botanik* **27A**(3): 1-103.
- Singh KP. 1984. Synopsis of lichens from Palni Hills, India. *Biological Memoires* **9** (2): 105-150.
- Singh KP, Sinha GP. 1994. *Flora of Nagaland*. Bishen Singh Mahindra Pal Singh, Dehradun, Pp. 1-498.
- Sipman HJM. 1994. New Graphidales (lichenized Ascomycota) from the Guianas and nearby areas. *Acta Botanica Fennica*, **150** 165-172.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. *Biblio Lichenol.* **85**: 1-526.
- Vainio EA. 1921a. Lichenes insularum Philippinarum, III. *Annales of Academiae Scientiarum Fennicae*, **15**:5-368.
- Vainio E.A. 1921b. Lichenes in summon monte Doi Sutep (ca. 1675 m.s.m) in Siam boreali anno 1904 a D re C.C. Hosseo collecti. *Annales Soceitatis Zoolog-Botanicæ Fennicæ* 'Vanamo' **1**: 33-55.
- White FJ, James PW 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bull. British Lichen Soc.* **57**: 1-41 (Suppl.)
- Wirth M., Hale ME. 1963. The lichen family *Graphidaceae* in Mexico. *Contributions from the United States National Herbarium* **36**: 63-119.
- Wirth M. Hale, M.E. 1978. Morden-Smithsonian Expedition to Dominica: The Lichens (*Graphidaceae*). *Smithsonian Contributions to Botany* **40**: 1-64.

The genus *Campanella* in Western Australia

NEALE L. BOUGHER

neale.bougher@dec.wa.gov.au

Department of Environment and Conservation, Western Australian Herbarium
Locked Bag 104, Bentley Delivery Centre, WA 6983, Australia

Abstract—Two species of *Campanella* are noted. The genus was previously unrecorded in Western Australia. *Campanella gregaria* sp. nov. predominantly occurs on rotting wood and bark of *Banksia* and *Eucalyptus* in south Western Australia. *C. gregaria* can be recognized by having often numerous, dull dark brown to grey, tiny, shell-shaped to cup-shaped, gelatinized basidiomes with an extensively anastomosed, almost poroid hymenophore. It is affiliated with species in *Campanella* subsection *Floridanae*, perhaps closest to the northern East Asian species *Campanella boninensis*. A second species of *Campanella* from Western Australia is noted but not formally described pending further collections.

Key words—Agaricales, Marasmiaceae, taxonomy

Introduction

Campanella Henn. is a saprotrophic genus of white-spored fungi with small, shell-like basidiomes produced on rotting stumps, logs and other dead wood. The majority of species of *Campanella* occur in tropical, subtropical and southern temperate regions (Segedin 1993). An exception is *C. boninensis* (S. Ito & S. Imai) Parmasto from temperate regions of East Asia such as Japan and Russia. Currently 56 names are listed for the genus (Index of Fungi, Farr et al. 2005). Four named species of *Campanella* have been reported in Australia (May & Wood 1997) and four other species in New Zealand (Segedin 1993).

The genus *Campanella* is well defined by a set of distinctive morphological features (Singer 1986). The basidiomes are often semi-transparent, strongly gelatinized, and have anastomosing ridges that interlink the lamellae. The hymenophore is poroid or favoloid in some of the more strongly anastomosed species. Microscopically the genus is characterized by inamyloid spores, abundant clamp connections, and a rameales pileipellis. *Favolaschia* resembles poroid species of *Campanella* but has amyloid spores.

A close relationship between *Campanella* and *Tetrapyrgos* is indicated by morphology and by some molecular studies but the degree of distinction

between these genera remains unresolved. At least some species of *Campanella* have the triangular or pastie-shaped spores typical of *Tetrapyrgos*. Singer (1986) did not accept *Tetrapyrgos* (*Pterospora*) and placed its species in *Marasmiellus* and *Campanella*. Phylogenetic analyses of the rDNA nuclear large subunit gene by Moncalvo et al. (2002) indicate that *Campanella* is a sister group to *Tetrapyrgos* within a tetrapyrgoid clade of fungi with gelatinized pilei, clamp connections, rameales type of pileipellis structure, and inamyloid spores. The tetrapyrgoid clade is in turn entrenched within a clade of saprotrophic fungi traditionally assigned to the *Marasmiaceae* including some *Marasmius*, *Crinipellis* and *Chaetocalathus* species (Moncalvo et al. 2002). Analyses of rDNA sequences by Thorn et al. (2005) show two un-named species of *Campanella* nested within a *Tetrapyrgos* clade. A multi-locus cladogram by Matheny et al. (2006) has a terminal clade in the *Marasmiaceae* comprised of an un-named species of *Campanella* and *Tetrapyrgos subdendrophora*. A *Tetrapyrgos* clade derived from rDNA sequences by Wilson & Desjardin (2005) does not contain the only species of *Campanella* in their study - *Campanella eberhardtii* (Pat.) Singer.

Within *Campanella* Singer (1975) nominated two sections based on presence or absence of metuloids. *Campanella* included species with small broadly ellipsoid to subglobose spores and dark pigmentation. Those species may extend the generic boundary of *Campanella* towards *Resupinatus*, a genus with similar basidiomes (Pegler 1986). Previously *Resupinatus* was considered only to include species without an interveined hymenophore (Singer 1986), but poroid species are now accepted in *Resupinatus* (Thorn et al. 2005). Recognition of the two genera is supported by molecular analyses: *Resupinatus* species occur in a separate clade to the tetrapyrgoid clade containing *Campanella* species in the analysis of Moncalvo et al. (2002), and the genera are also well separated in Thorn et al. (2005).

This present paper describes a new species of *Campanella* subsection *Floridanae* characterized by its dark brown to grey, non-vinaceous, non-staining, gelatinized basidiomes, strongly anastomosed hymenophore, and predominantly subglobose spores.

Description of the species

Campanella gregaria Bougher, sp. nov.

MYCOBANK # MB 510526

Pileus ad 8 (-12) mm diam, primo cupulatus dein umbonato-applanatus flabelliformis, dimidatus vel conchatus vel orbiculatus, primo pallide maturitate sordide dein pallide luteus vel cremeus, gelatinosus. Caro gelatinescens. Hymenophorum cremeum dein concolorum, lamelliis ad 15 ad punctum excentricum radiantibus, anastomosantibus. Stipes nullus. Odor nullus. Sapor mitis. Sporae 4.9 - 6.1 (6.3) x 4.2 - 5 (5.3) μ m, dominante subglobosae,

Figure 1

laeves, hyalinae inamyloideae. Cystidia 20–40 x 2–5 µm, filiformia, irregularia, raro sublancoolata, laevia. Septa hypharum fibulata. Gregaria, lignicola, in sylvis, Australia Occidentalis, 30.6.2004.

Holotypus: Ken Hurst Park, Perth, 32° 4' 44.72" S 115° 52' 51.43" E, Western Australia, 13 June 2004, N.L. Bougher & N. Carrington E8006 - Holotypus: PERTH.

Etymology: from the Latin adjective *gregarius* = growing in companies but not united together. In reference to this fungus often having multitudes of basidiomes in crowded groups.

Basidiomes 2–8 (–12) mm diam., some basidiomes fused laterally, at first cupulate with strongly inrolled, thick margin surrounding a narrow circular aperture that widens with age. Mature basidiomes flabelliform, dimidate to conchate (basidiomes on vertical side of wood), or orbicular (basidiomes under horizontal side of wood), with wavy, undulating, sometimes sulcate, thin margin; **surface** dry but jelly-like with age, smooth or with minute pruinosity visible under lens in young specimens, translucent showing tessellated–mottled pattern of the hymenophore, color variable depending on degree of gelatinisation but usually dull greyish-brown (7E5), paler when young, sometimes becoming very pale or yellowish cream (4A3) when older or particularly when gelatinized, vinaceous or bluish tinges absent at all stages, dark grey to black when dried; **stipe** absent, basidiomes broadly attached laterally, excentrically, or central dorsally; **hymenophore** cream at first then concolorous with pileus, with up to 15 lamellae radiating out from an excentric point (flabelliform, dimidate to conchate basidiomes) or central point (orbicular basidiomes), radial pattern less dominant or conspicuous in mature basidiomes than young basidiomes and very obscure in mature orbicular basidiomes, anastomosing cross walls between lamellae forming crowded poroid pattern of polygonal and irregular locules, some anastomoses forming partial intrusions into the locules, isolated lamellulae rare or absent, lamellae and anastomoses are of same height (up to 1 mm tall) and thickness; **context** firm, fleshy, jelly-like at first then increasingly flabby, gelatinous with age, finally collapsed; **mycelium** not visible on substrate surface between basidiomes; **odor** not distinctive; **taste** mild; **spore print** white.

Basidiospores 4.9 – 6.1 (6.3) x 4.2 – 5 (5.3) µm (n = 30), mean 5.58 x 4.77 µm, L/B ratio 1.07–1.24, mean 1.17, hyaline in 3% KOH or water, inamyloid, predominantly subglobose, some broadly ellipsoid or subovoid, smooth, thin-walled; **basidia** 22–30 x 5–7 µm, cylindro-clavate to clavate, hyaline, thin-walled, sterigmata to 4–7 µm in length, 4-spored, clamped at base, subtended by narrow hypha 1.5 µm broad, arranged in tightly packed hymenium which collapses and/or gelatinises post-maturity; **basidioles** narrow, cylindric; **lamellae trama** loosely entangled hyphae 1.5–2 µm broad, hyaline, smooth-walled, all septa clamped, becoming gelatinized; **subhymenium** hyphae similar

to trama; **cystidioid elements** 20–40 x 2–5 μm , mostly filiform, sometimes irregular, rarely sublanceolate, rarely with hyphal-like extension, hyaline, smooth-walled and without encrusted tips, usually single accompanying a basidium, not associated with every basidium, not usually emerging beyond hymenium; **pileipellis** a dense tangled rameales layer directly emanating from the loosely entangled hyphae of the pileus trama, composed of coralloid elements up to 2 (2.5) μm broad, with short, blunt-tipped branches, often branching at right angles and tapering towards the tips, elements with intracellular brown pigment (seen in KOH or water), in young specimens hyphal tips emerge from the pileipellis as minute horn-like structures, in older specimens the walls of many tapered hyphal tips dissolve into a gelatinous material without crystalline material present; **pileus trama** of hyaline, thin-walled, smooth, hyphae (1.5–2 μm broad), very loosely entangled in a hyaline gelatinised matrix, most hyphal walls remain intact; **clamp connections** present, large, including some medallion clamps, some associated with abruptly swollen septa.

Habit and Habitat—In crowded clusters spread over dead wood in natural forests and woodlands dominated by *Eucalyptus* and *Banksia*, on fallen logs of *Banksia* species, usually growing on the inner side of loose rotting bark, and on burnt and unburnt logs and stumps of Jarrah (*Eucalyptus marginata*) and *Allocasuarina* species. Variable in number, usually from 10 to in excess of 100 basidiomes. May to July.

Specimens examined—AUSTRALIA. WESTERN AUSTRALIA: Ken Hurst Park, Perth, 32° 4' 44.72" S 115° 52' 51.43" E, on fallen rotting banksia wood in banksia woodland, 13 June 2004, coll. N. Bougher & N. Carrington E8006 - holotype here designated (PERTH). Kings Park, Perth, in bushland near southern end of Hale Oval – Ivey Watson Playground, 31° 57' 18.86" S 115° 50' 13.09" E, on fallen rotting banksia wood in banksia woodland, 9 June 2004, coll. N. Bougher & J. Weaver E8004 (PERTH). Bold Park, Perth, 31° 57' 28.9" S 115° 46' 17.4" E, on bark of fallen rotting banksia wood in banksia and jarrah (*Eucalyptus marginata*) woodland, 29 June 2004, coll. N. Bougher & R. Hart E8034 (PERTH). Dwellingup, ALCOA World Alumina Australia bauxite mining lease, Wuka Rd, 32° 35' 28.8" S 116° 4' 29.3" E, on surface of a jarrah (*Eucalyptus marginata*) stump in natural jarrah forest, 27 June 2001, coll. N. Bougher E6816 (PERTH). Dwellingup, ALCOA World Alumina Australia bauxite mining lease, Nettleton Rd, 32° 35' 26.9" S 116° 4' 23.1" E, on old rotting jarrah (*Eucalyptus marginata*) wood lying on the ground in natural jarrah forest, 28 June 2001, coll. M. Glen E6887 (PERTH). Boddington, Worsley Alumina Pty Ltd bauxite mining lease, Nettleton Rd, 32° 58' 38.5" S 116° 27' 9.7" E, in dense clusters of about 20 basidiomes on wood in natural jarrah forest of *Eucalyptus marginata*, 16 July 2001, coll. M. Glen E6991 (PERTH). Dwellingup, ALCOA World Alumina Australia bauxite minesite, Nettleton Rd, 32° 35' 26.9" S 116° 4' 23.1" E, on the ground in 4-year-old rehabilitated forest of *Eucalyptus marginata*, *Acacia* sp., 11 June 2002, coll. D. Willyams E7144 (PERTH). Serpentine, Lowlands, about 1km north of Lowlands Rd and gate to private property, 32° 19' 11.4" S 115° 55' 30.9" E, on bark of fallen rotting *Banksia attenuata* wood in banksia and jarrah (*Eucalyptus marginata*) woodland, 20 May 2006, coll. K. Griffiths, N. Goldsborough, M. Langley & P. Robertson E8314 (PERTH).

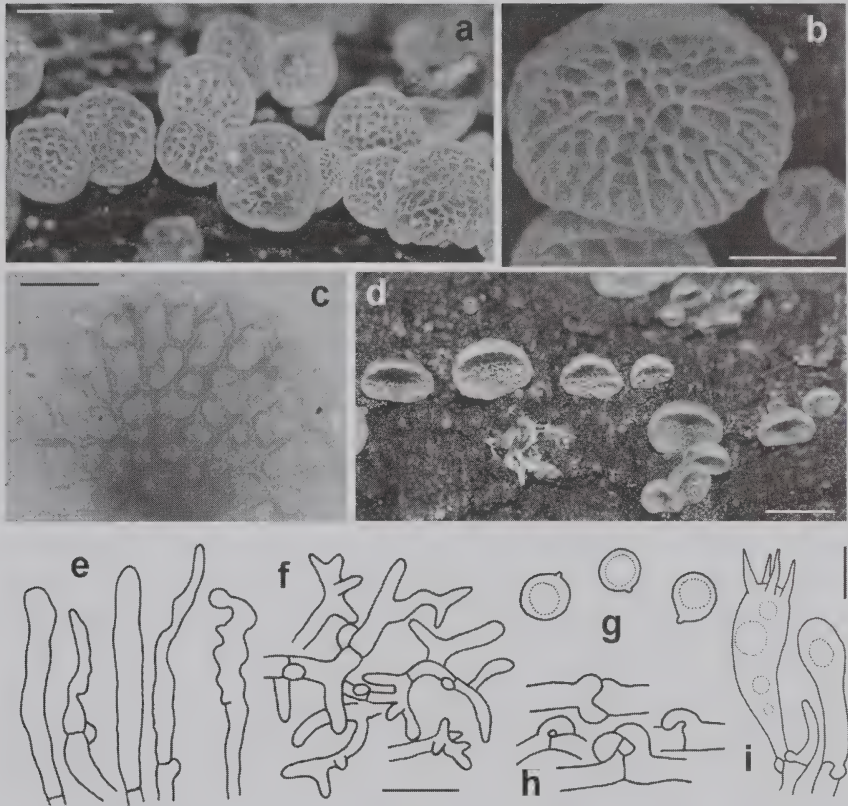


Fig. 1. *Campanella gregaria*: a. Young basidiomes (Holotype) b. Mature basidiomes (E8314) c. Young hymenophore revived in 3% KOH after drying (E8004). Note the incomplete anastomoses projecting into the locules. d. Mature basidiomes (Holotype) e. Cystidia and cystidia-like elements in the hymenium f. Coralloid elements in the pileipellis g. Basidiospores h. Trama hyphae with large clamp connections i. A developing basidium and a mature basidium

Scale bars: a, d = 5 mm, b = 2 mm, c = 1 mm, e-i = 10 μ m (bar in f applies to e-h).

Comments—*Campanella gregaria* can be recognized by its dull dark brown to grey, tiny shell-shaped to cup-shaped, gelatinized basidiomes often numerous on rotting wood. Young basidiomes that are dorsally attached due to their position on the under side of logs appear cup-shaped. They have a thick, inrolled margin that encircles a narrow aperture. As the basidiome expands, the aperture widens and the margin unrolls to reveal the poroid hymenophore. Basidiomes have up to 15 radiating lamellae. The lamellae are interlinked by secondary anastomosing cross-walls of similar height that form a crowded poroid pattern of polygonal and irregular locules. Radial lamellae are mostly evident in young

specimens and in excentrically attached mature specimens (Figure 1b). In dorsally attached, circular-shaped basidiomes the lamellae can become obscured amid a predominantly non-radial, poroid hymenophore (Figure 1a). The extent of anastomosing is not affected by size of the basidiome. Old basidiomes become paler and can transform into a soft gelatinous amorphous mass often engulfing several adjacent basidiomes. Air-dried specimens of *C. gregaria* are dark grey or black. Dried specimens rapidly revive and swell up to their original size and shape and pale yellow-brown colour in KOH or water (Figure 1c).

Taxonomic relationships of *Campanella gregaria*—The spores of *C. gregaria* are predominantly subglobose to almost globose with an average length/breadth ratio of 1.1 to 1.2. *C. gregaria* therefore is affiliated with section *Campanella* Singer as defined (Singer 1986) by absence of metuloids, and belongs in subsection *Floridanae* Singer, defined by short, ellipsoid to subglobose spores to 6.5 μm long, or, if longer, arising from bisporic basidia (Singer 1986).

Four named species of *Campanella* have been reported in Australia (May & Wood 1997), all outside Western Australia. None represent the subsection *Floridanae*. (1) *C. gigantospora* Singer has large spores (11–15.5 $\times$ 9.5–12 μm) and diverticulate cystidia (Singer 1986). (2) *C. junghuhnii* (Mont.) Singer has light-coloured pilei and larger (7.4–10.6 $\times$ 4.8–6.7 μm), ellipsoid spores (Parmasto 1981). (3) *C. olivaceonigra* (E. Horak) T.W. May & A.E. Wood reported from New Zealand and Australia (May 1989) has angular, tetrahedral spores (8–10 $\times$ 5–6 μm , Horak 1983), and previously has been assigned to the genera *Pterospora* and *Tetrapyrgos* before more recent placement in *Campanella* (May & Wood 1995). (4) *C. pustulata* (Berk. & Broome) Pegler has large (10–14 $\times$ 6–7.5 μm) amygdaliform spores (Pegler 1986). All Australian reports of *C. pustulata* are based on a record named *Laschia pustulata* Berk. & Broome by Cooke (1892) which is considered by many authors to be a misidentification (May & Wood 1997). The identities of *Campanella* sp. reported in South Australia by Burns & Conran (1997), and the Australian fungi depicted as *Campanella* species by Heino Lepp at www.anbg.gov.au/fungi/images are unconfirmed.

Four species of *Campanella* have been reported from New Zealand (Segedin 1993) in addition to *C. olivaceonigra*. *Gloioccephala rubescens* (Segedin) Desjardin & E. Horak (formerly *C. rubescens* Segedin) and *C. tristis* (G. Stev.) Segedin have staining basidiomes and ellipsoid spores. *C. fimbriata* Segedin has stipitate basidiomes and broadly ellipsoid to ovate spores. *C. vinosolivida* Segedin is the only known New Zealand representative of *Campanella* that may be considered close to members of subsection *Floridanae*. Segedin (1993) indicates possible affinities of *C. vinosolivida* with species of subsection *Floridanae* such as *C. boninensis* and *C. purpureobrunnea* Petch, but it differs from them by having

diverticulate cystidia, ellipsoid spores, and more complex pileipellis elements. It differs from *C. gregaria* by having large brightly-coloured basidiomes with margin not inrolled, elliptic-oblong spores, and strongly diverticulate cheilocystidia. The hymenophore of *C. vinosolivida* is rather crowded (see Fig. 4, Segedin 1991). However *C. gregaria* does not share with *C. vinosolivida* lamellulae that remain isolated from the poroid hymenophore. Also the radial lamellae are less dominant at maturity in *C. gregaria* than in *C. vinosolivida*, particularly in circular-shaped basidiomes.

Species of *Campanella* in the Subsection *Floridanae* (Singer 1975) to consider in relation to *C. gregaria* include *C. podocarpi* Singer, *C. floridana* Singer, *C. alnetorum* Singer, *C. caerulescens* (Berk. & M.A. Curtis) Singer, and *C. boninensis*. *C. podocarpi* has scarcely anastomosed lamellae, bisporic basidia and occurs on conifers in South America (Singer 1975). *C. floridana* has narrow anastomoses, no cystidia, and occurs on *Magnolia* in Florida (Singer 1975). *C. alnetorum* from Argentina has distant and forked lamellae, grayish fuscous circular basidiomes 12-13 mm broad, subglobose spores $4.5-5 \times 4-4.5 \mu\text{m}$, narrowly cylindric basidioles, no thin- or thick-walled cystidia, and a broad non- or weakly-gelatinised epicutis layer (Singer 1975). *C. caerulescens* is a neotropical species with white or yellowish basidiomes that become bluish purple with age (Singer 1975). *C. boninensis* from East Asia has (data from Parmasto 1981): (1) small dull brown vinaceous almost sepia, astipitate basidiomes; (2) alveolate hymenium with concurring radiating lamellae; (3) narrow, loosely arranged clamped hyphae embedded in gelatinous matter; (4) epicutis of nodulose end cells with short side branches; (5) cheilocystidia rare or very rare; (6) small, broadly ellipsoid to subglobose spores ($4.8-6.4 \times 3.8-5 \mu\text{m}$). *C. gregaria* may represent a southern hemisphere taxon with non-vinaceous basidiomes that is more closely related to *C. boninensis* than to any other known *Campanella* species.

C. gregaria also may be compared with *C. purpureobrunnea* from Sri Lanka as that species has small, abundant blackish brown to purplish brown basidiomes which uniformly blacken on drying (Pegler 1986). *C. purpureobrunnea* was incorrectly placed in the metuloid-bearing Section *Diplocystides* by Singer (1986). According to Pegler (1986) it lacks cystidia. *C. purpureobrunnea* differs from *C. gregaria* by having darker, purplish basidiomes and smaller, narrower spores ($4-5.5 \times 3.5-4.5 \mu\text{m}$) (Parmasto 1981, Pegler 1986).

A second species of *Campanella* in Western Australia—This species, currently represented only by a single collection, also belongs in subsection *Floridanae*, possibly closest to the purplish species such as *C. purpureobrunnea*. It has similar spores ($4.5-5.6 \times 4.0-5.1 \mu\text{m}$) to *C. gregaria* but differs from that species

by: (i) purplish date colour of the lamellae and the pilei and markedly crenate/lobed margin; (ii) more frequent occurrence of coralloid, knobby cystidia, including some branched cystidia. Determination of its identity awaits further collections.

It is likely that species of *Campanella* in addition to this one and *C. gregaria* occur in Western Australia, as this region spans a broad range of vegetation types and climatic regions (e.g. temperate, tropical).

Specimen examined—AUSTRALIA. WESTERN AUSTRALIA: Manjimup, Pine Creek Road, on old log of *Allocasuarina* sp. in natural forest of karri (*Eucalyptus diversicolor*), 13 June 1985, coll. N. Bougher E3689 (PERTH).

Acknowledgments

Part of this research was facilitated by the Perth Urban Bushland Fungi Project – financially supported by Lotterywest, and facilitated by the Urban Bushland Council and the Western Australian Naturalists' Club in conjunction with the Western Australian Herbarium. The author wishes to thank Dr Tom May and Dr Teresa Lebel, Royal Botanic Gardens Melbourne for critically reviewing this manuscript.

Literature Cited

- Burns A, Conran JG. 1997. The phenology of macrofungi in relation to autumn rainfall in the Adelaide Hills. *Muelleria* 10: 95–109.
- Cooke MC. 1892. Handbook of Australian fungi. London, Williams and Norgate.
- Farr DE, Rossman AY, Palm ME, McCray EB. 2005. Fungal Databases, Systematic Botany & Mycology Laboratory, ARS, USDA. Retrieved October 14, 2004, from <http://nt.ars-grin.gov/fungaldatabases/>.
- Horak E. 1983. Neufunde und bemerkungen zu einem emendierten Gattungskonzept von *Pterospora* Metrod. (Agaricales). *Sydowia* 36: 125–38.
- Matheny PB, Curtis JM, Hofstetter V, Aime CM, Moncalvo J-M, Ge Z-W, Yang Z-L, Slot JC, Binder M, Ammirati JF, Baroni TJ, Bougher NL, Wang Z, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, McLaughlin DJ, Padamsee M, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Major clades of *Agaricales*: a multi-locus phylogenetic overview. *Mycologia* 98: 984–997.
- May TW. 1989. Report of F.N.C.V. fungal excursions: 1986–1988. *Victorian Naturalist* 106: 48–58.
- May TW, Wood AE. 1997. Fungi of Australia Vol. 2A. Catalogue and Bibliography of Australian Macrofungi 1. *Basidiomycota* p.p. Australian Biological Resources Study, Canberra.
- May TW, Wood AE. 1995. Nomenclatural notes on Australasian macrofungi. *Mycotaxon* 54: 147–150.
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime CM, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn GR, Jacobsson S, Clemençon H, Miller OK Jr. 2002. One hundred and seventeen clades of euagarics. *Molecular Phylogenetics and Evolution* 23: 357–400.
- Parmasto E. 1981. On the Asian species of the genus *Campanella* (*Tricholomataceae*: *Collybieae*). *Nova Hedwigia* 34: 437–447.
- Pegler DN. 1986. Agaric flora of Sri Lanka. *Kew Bulletin, Additional. Series* 12: 1–519.

- Segedin BP. 1993. Studies in the *Agaricales* of New Zealand: some new and revised species of *Campanella* (*Tricholomataceae: Collybieae*). *New Zealand Journal of Botany* 31: 375-384.
- Singer R. 1975. The neotropical species of *Campanella* and *Aphyllotus* with notes on some species of *Marasmiellus*, *Nova Hedwiga* 26: 847-895.
- Singer R. 1986. *The Agaricales in Modern Taxonomy*. Königstein, Koeltz Scientific Books.
- Thorn RG, Moncalvo J-M, Redhead SA, Lodge DJ, Martin MP. 2005. A new poroid species of *Resupinatus* from Puerto Rico, with a reassessment of the cyphelloid genus *Stigmatolemma*. *Mycologia* 97: 1140-1151.
- Wilson AW, Desjardin DE. 2005. Phylogenetic relationships in the gymnopoid and marasmiod fungi (Basidiomycetes, euagarics clade). *Mycologia* 97: 667-679.

***Hygrophorus penarioides*, a new species identified using morphology and ITS sequence data**

S. JACOBSSON & E. LARSSON

stig.jacobsson@dpes.gu.se

Dept. of Plant- and Environmental Sciences, Göteborg University

P.O. Box 461, SE-405 30 Göteborg, Sweden

Abstract—*Hygrophorus penarius* sensu lato is a whitish, dry or only slightly viscid, rather robust mushroom forming ectomycorrhizae with *Fagus sylvatica* or *Quercus* spp. There are slight morphological differences between the *Fagus* and the *Quercus* forms. The taxonomy has been complicated. Both forms have been interpreted as *Hygrophorus penarius*. Based on ITS sequence data it is here shown that they ought to be looked upon as two distinct species. As no reliable name in the literature could be used that fits the species associated with *Quercus* it is here described as a new species, *Hygrophorus penarioides*.

Key Words—Basidiomycotina, Agaricales, phylogeny

Introduction

Fries described *Hygrophorus penarius* 1836 and then stated that the species was found in beech forests of southern Sweden. In *Epicrisis Systematis Mycologici* 1838, the habitat was indicated as “silvis mixtis, praecipue fagetis”. These statements correspond well with a mushroom rather frequently fruiting in Swedish *Fagus* forests, e.g. in Femsjö, Fries’s home parish. Another form is associated with *Quercus* and has a very limited distribution in Sweden. It is restricted to calcareous soils, and most likely Fries never saw it. The morphological variation within *H. penarius* was observed by Becker (1954), who divided it into two species and described *Hygrophorus barbatulus*. Unfortunately, Becker applied the new name to the species growing with *Fagus* and retained *H. penarius* for the larger form under *Quercus*, ignoring that the description by Fries unambiguously indicated the *Fagus* form. Consequently, *H. barbatulus* G. Becker is a synonym of *H. penarius* Fr., leaving the *Quercus* form without a name.

Bon keyed out the two forms as rather well distinguished species (Bon 1977) or varieties (Bon 1992) but retained *H. penarius* for the taxon under *Quercus* and called the taxon under *Fagus* *H. barbatulus* or *H. penarius* var. *barbatulus*

(G. Becker) Bon. However, other authors such as Arnolds (1986) and Krieglsteiner (2001) did not separate them.

A molecular study using ITS sequence data was therefore undertaken to investigate the taxonomical status of the two forms in Europe. The ITS region was selected since an earlier study in *Hygrophorus* showed the region to be suitable for disentangling morphologically similar species and the study also indicated the species within *Hygrophorus* to be strictly host specific (Larsson & Jacobsson 2004).

Materials and methods

Data on sequenced specimens are provided in Table 1. We generated three sequences of both the *Fagus* and the *Quercus* forms using collections originating from different localities. In addition, a sequence of *H. sordidus* Peck was included to exclude the possibility that the North American species could occur in Europe and represent the *Quercus* form. We selected three morphologically related species as outgroup, *H. nemoreus* (Pers.) Fr. and *H. russula* (Schaeff.) Kauffman associated with *Quercus*, and *H. poetarum* R. Heim associated with *Fagus*.

Collections have been deposited at the herbarium of the Department of Plant- and Environmental Sciences, Göteborg University (GB). Additional specimens of the new species *H. penarioides* are listed under the species description. Additional specimens morphologically examined of *H. penarius* are listed below.

Hygrophorus penarius: Sweden: Sm., Femsjö, Lidhult-Femsjö, 7 Sep. 1957, T. Nathost-Windahl and M. Moser (NW6446); Voxtorp, Rusaebro, 19 Sep 1972, J. Eriksson. Hl: Veddige, Björkholm, 7 Sep 1958, F. Karlvall (FK8264); Älvsåker, Mariedal, 11 Sep. 1966, F. Karlvall (FK11905); Fjärås, Fagared, 11 Oct. 1980, S. Jacobsson (SJ80290). Boh: Romelanda, Grandalen, 7 Oct. 1978, S. Jacobsson (SJ78249); Bokenäs, 2 Sep. 1988, L. & A.- Stridvall (LAS88/141-B); Sotenäs, Tossene, 6 Oct. 2004, L. & A. Stridvall (LAS 04/145). Vg: Tostared, 5 Sep. 1973 J. Eriksson; Partille, Bokedalen, 27 Sep 1997, S. Jacobsson (SJ97027).

Sequences were obtained from fresh material and herbarium specimens (Tab. 1). Total DNA was isolated using DNeasy plant mini kit (QIAGEN, Valencia), following manufacturers recommendations. PCR reactions were carried out using Ready-To-Go™ PCR beads (Amersham Biosciences, Uppsala). Primers used to amplify the complete ITS region were ITS1F and ITS4B (Gardes & Bruns 1993). Amplified products were purified using Qiaquick spin columns (QIAGEN, Hilden). Primers used for sequencing were ITS1, ITS3, ITS4 (White et al. 1990). Fifty to 75 ng of PCR products were used in each sequencing reaction using DTCS Quick Start Kit (Beckman Coulter, Fullerton). Sequences were obtained using CEQ 8000 DNA analysis system (Beckman Coulter).

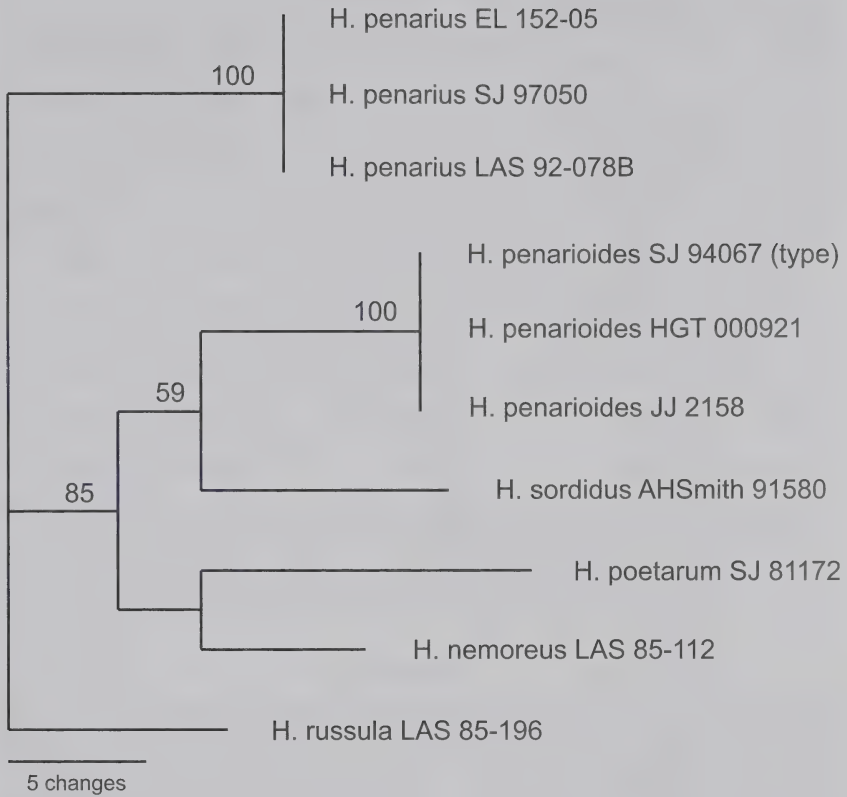


Figure 1. One of the most parsimonious trees from the phylogenetic analysis presented as a phylogram, showing the phylogenetic placement of *Hygrophorus penarioides*. Bootstrap values greater than 50% are indicated above branches.

Sequences were edited and assembled using Sequencher 3.1 (Gene Codes, Ann Arbor) and aligned manually using the data editor in PAUP* (Swofford 2003). Sequences generated in this study have been deposited in GenBank and accession numbers are given in Table 1.

Heuristic searches for most parsimonious trees were performed using PAUP*. All transformations were considered unordered and equally weighted. Variable regions with ambiguous alignment were excluded and gaps treated as missing data. Searches used 1000 random-addition sequence replicates and TBR branch swapping. Relative robustness of clades was assessed by the bootstrap method using 1000 heuristic search replicates with 100 random taxon addition sequence replicates and TBR branch swapping.

Table 1. Data of sequenced collections

Species	Collection id.	Origin	Host	Accession nr.
<i>H. penarius</i>	EL152-05	Swe., Sk.	<i>Fagus</i>	EF395367
<i>H. penarius</i>	SJ97027	Swe., Vg.	<i>Fagus</i>	EF395368
<i>H. penarius</i>	LAS92-078	Swe., Boh.	<i>Fagus</i>	EF395369
<i>H. penarioides</i>	JJ2158	Swe., Vg.	<i>Quercus</i>	EF395372
<i>H. penarioides</i>	HGT000921	Swe., Gtl.	<i>Quercus</i>	EF295371
<i>H. penarioides</i>	SJ94067, Type	Swe., Öl.	<i>Quercus</i>	EF395370
<i>H. nemoreus</i>	LAS85-112	Swe., Vg.	<i>Quercus</i>	EF395374
<i>H. poetarum</i>	SJ81172	Swe., Sk.	<i>Fagus</i>	EF395375
<i>H. russula</i>	LAS85-196	Swe., Boh.	<i>Quercus</i>	EF395376
<i>H. sordidus</i>	AHSmith91580	USA., Wisc.	<i>Quercus</i>	EF395373

Results

The aligned dataset had 546 characters. After exclusion of ambiguous areas 375 characters remained for the analyses. Of these 325 were constant, 23 variable and parsimony uninformative, and 27 parsimony informative. Maximum parsimony analyses yielded two equally most parsimonious trees (length = 63, CI = 0.9048, RI = 0.9032). One of the two most parsimonious trees is presented in Figure 1. Bootstrap frequencies above 50% have been indicated on branches.

The bootstrap analysis recovered the three sequences of *H. penarius* with 100% bootstrap support and the three sequences of *H. penarioides* with 100% bootstrap support. The sequence differences between the two clades are 31 substitutions and 18 insertion/deletion events. The sequence of *H. sordidus* clusters with *H. penarioides* with 59% bootstrap support (Fig. 1). The sequence difference between the North American and the European species with similar morphology and associated with *Quercus* is 22 substitutions and 12 insertion/deletion events.

The phylogenetic analyses clearly verify the occurrence of two distinct species in Europe and that the North American species *H. sordidus* is different from the *Quercus* form in Europe. The species associated with *Fagus* is *H. penarius* and the other species associated with *Quercus* is here described as *H. penarioides*.

Species description

Hygrophorus penarioides Jacobsson & E. Larss. sp. nov.

Fig. 2

MYCOBANK # MB510527

Misapplication: *Hygrophorus penarius* Fr. var. *penarius* ss Bon

Pileus 90–150 mm *latus*, *primo cum umbone lato vel convexus et margine valde involuto*, *primo pure albus*, *sed dein in disco plus vel minus cremeopaleaceus, glaber, subviscidus vel siccus. Lamellae decurrentes, distantes vel distantissimae, primo albae, sed deinde cum colore cremeopaleaceo vel modice roseo. Stipes* 60–100 x 15–35 mm, *firmus et confertus, generatim deorsum valde attenuatus, albus, sed deorsum quidem cum colore cremeopaleaceo vel ochraceo, in summa parte tenuiter floccosus. Sapor mitis vel paene mitis. Odor levis et difficilis ad describendum (oleosus vel dulcidulus). Sporae late ellipsoides vel ovatae, (5–)5.5–6.5(–7) x 4–4.5 µm. Q = 1.3–1.6. Basidia graciliter clavata, 50–60 x 6–8 µm, quadrispora. Pileipellis crassa ixocutis ex 3–6 µm latis hyphis. Habitatio: sub Quercu/Corylo in terra calcarea. Certe mycorrhizam formans cum Quercu.*

Holotypus—Sweden, Öland, Långlöt parish, N Ismantorp, 1 Oct. 1994., SJ 94067: in herbarium GB *conservatus est*.

Etymology—Similar to *penarius*

Pileus 90–150 mm broad, when young with a broad umbo or convex with a strongly involute margin, pure white at first but with age becoming more or less cream in centre, smooth, subviscid to dry. **Lamellae** decurrent, distant to very distant, white at first but later with a cream or slightly pinkish flush. **Stipe** 60–100 x 15–35 mm, firm and compact, mostly strongly attenuated towards the base, white but at least in lower part with a cream or ochraceous flush, finely floccose in the uppermost part, taste mild or almost so. **Odour** present, but weak and difficult to describe (oily or sweetish). **Basidiospores** broadly ellipsoid to ovoid, (5–)5.5–6.5(–7) x 4–4.5 µm. $Q = 1.3–1.6$. **Basidia** slenderly clavate, 50–60 x 6–8 µm, 4-spored clamped. **Hyphae** with clamps. **Gill edge** fertile. **Pileipellis** a thick ixocutis of 3–6 µm broad hyphae.

Habitat under *Quercus/Corylus* on calcareous ground. Fruiting time (in Scandinavia) Sept. – Oct., forming ectomycorrhiza with *Quercus*.

Additional collections: Sweden: Öl, Långlöt, Ismantorp, SO Vargmossen, 2 Oct. 1998, S. Jacobsson, SJ 98040; Vg., Österplana, 2 Oct. 1982, J. Jeppson 2158 ; Gtl., Lojsta, 21 Sep. 2000, HG. Thoresson .

Discussion

In the present study ITS sequence data confirm the occurrence of the two species *H. penarius* and *H. penarioides* in Europe. *Hygrophorus penarioides* is very similar to *H. penarius* in many aspects, e.g. the colours, the subviscid to dry pileus surface, the distant and decurrent lamellae and the robust habitus. Despite these facts it is not difficult to distinguish the two species. Apart from the different ecology there are clear morphological differences: *H. penarioides* has in average considerably larger basidiomes and the spores are slightly shorter

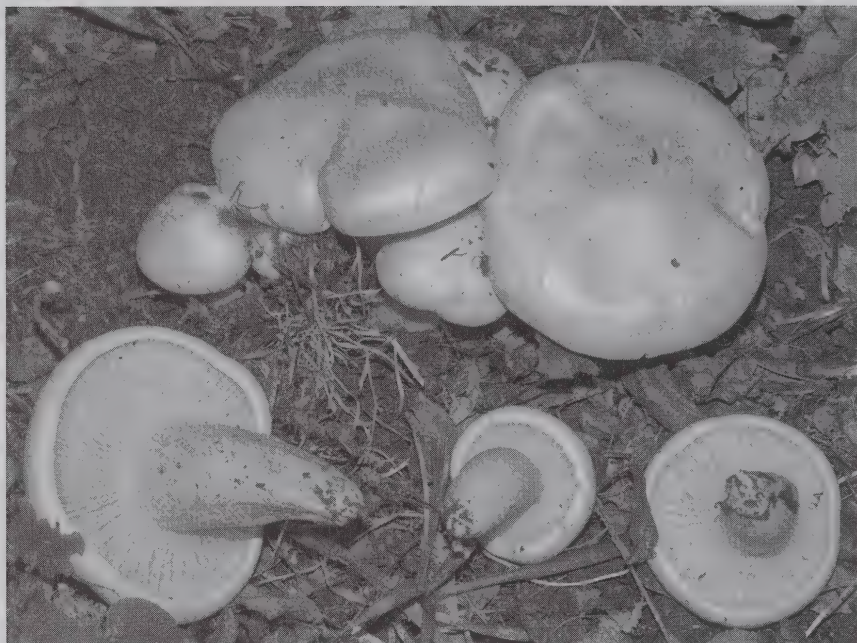


Figure 2. Fruitbodies of *Hygrophorus penarioides*. Foto Leif Stridvall.

with a Q value of 1.3-1.6 compared to 1.5-1.8 in *H. penarius*. There seems also to be a difference in odour but this is difficult to indicate as it is weak and may be differently perceived. Becker (1954) and Bon (1977) mention some other differences: *H. penarius* is said to be finely scaly towards the edge of the pileus (hence the name *barbatulus*) and to have a fully mild taste whilst *H. penarioides* is said to be smooth and to have a bitter taste. However, these characters do not seem to be constant. Only some of our collections of *H. penarius* are slightly appressed scaly while others look smooth and no bitter taste was perceived in the single collection of *H. penarioides* tested.

The North American species *Hygrophorus sordidus* is also similar to *H. penarioides*. *H. sordidus* also has very large basidiomes and the spores seem to be identical with those of *H. penarioides*. As *H. sordidus* is said to grow in oak/hickory woods (Hesler & Smith 1963) we first suspected it to be identical with the taxon connected with *Quercus* in Europe. Some collections of the species were borrowed from the Herbarum of University of Michigan (MICH). The only observed morphological difference between *H. penarioides* and *H. sordidus* is that the lamellae in *H. sordidus* seem to be closer, however we have not been able to study fresh material of the species. The large sequence divergence between them clearly indicates that they should be looked upon as distinct species.

In addition to Fig. 2 good illustrations of *H. penarioides* are found in the literature, e.g. in Cetto (1978: pl. 659), Marchand (1973: pl. 155) and Michael et al. (1979), all under the name *H. penarius*.

In Sweden *H. penarioides* has been collected or observed at localities on the calcareous islands Öland and Gotland in the Baltic sea, always in *Quercus*/*Corylus* woods. It has also been collected on Kinnekulle in the province of Västergötland, where the same type of calcareous bed-rock and vegetation occurs. Two collections of *H. penarius* from *Quercus* forests in Norway are preserved in Herbarium O. Very likely these in fact represent *H. penarioides*. To our knowledge it has not been collected in the other Nordic countries. The Swedish and Norwegian localities are apparently northern outposts of a species widespread in central and southern Europe (e.g. southern Germany, France and Italy) and seemingly not rare. Bon (1977) states that it is common in Mediterranean oak woods.

Acknowledgements

We thank the curator of the Herbarium MICH for loan of collections and Hans-Jörgen Winqvist for help with the latin diagnosis. Financial support was received from The Swedish Taxonomy Initiative, ArtDatabanken SLU, to EL (Grant dha 146/05). We are also grateful to Drs G. Gulden, Oslo and H. Knudsen, Copenhagen, for presubmittal reviews the manuscript.

Literature cited

- Arnolds E. 1986. Notes on *Hygrophoraceae* - VII. - Persoonia 13: 69–76.
- Becker G. 1954. Un nouvel Hygrophore: *Hygrophorus barbatulus*. Schweiz. Z. Pilzk. 32: 91–92.
- Bon M. 1977. Clé analytique des *Hygrophoraceae* (suite). Documents mycologiques 7(27–28): 25–53.
- Bon M. 1992. Die Großpilzflora von Europa 1. *Hygrophoraceae*. Übersetzt und bearbeitet von A. Einhellinger. IHW-Verlag, Eching.
- Cetto B. 1978. Der grosse Pilzführer. Band 2. Trento.
- Fries E. 1836. Anteckningar öfver de i Sverige växande ätliga Svampar.
- Fries E. 1838. Epicrisis Systematis Mycologici.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. Molecular Ecology 2: 113–118.
- Hesler LR, Smith AH. 1963. North American species of *Hygrophorus*. Knoxville.
- Kriegelstein GJ. 2001. Die Großpilze Baden-Württembergs, Band 3. Verlag Eugen-Ulmer, Pliezhausen.
- Larsson E, Jacobsson S. 2004. Controversy over *Hygrophorus cossus* settled using ITS sequence data from 200 year-old type material. Mycological Research 108: 781–786.
- Marchand A. 1973. Champignons du nord et du midi 2. Perpignan.
- Michael E, Hennig B, Kreisel H. 1979. Handbuch für Pilzfreunde. Vol. 3. Jena.
- Swofford DL. 2003. PAUP*. Phylogenetic Analysis Using Parsimony (* and Other Methods). Version 4. Sinauer Associates, Sunderland, MA.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds) PCR Protocols: a guide to Methods and Applications, pp. 315–322. Academic Press New York.

Hygrophorus virescens is transferred to *Hygrocybe*

LETICIA MONTOYA* & VÍCTOR M. BANDALA

leticia.montoya@inecol.edu.mx & victor.bandala@inecol.edu.mx

*Dept. Biodiversidad y Sistemática, Instituto de Ecología
A.C., P.O. Box 63, Xalapa, Veracruz 91000, Mexico*

Abstract — The combination *Hygrocybe virescens*, long used in the popular literature for the species first described in *Hygrophorus*, is here formally proposed for the first time.

Key words — *Hygrophoraceae*, sect. *Hygrocybe*, nomenclature, valid publication

In their North American treatment of *Hygrophorus*, Hesler & Smith (1963) described *H. virescens* based on a single collection (Smith 56649) from a redwood forest near Trinidad, California, U.S.A. For forty years, the species has been cited only rarely in the literature (Largent 1985, Arora 1986), although there have been several mentions of collections displayed in annual mushroom fairs in both California and Oregon (Norvell pers. comm. 2007). The species had not been reported from outside the U.S.A. until Montoya et al. (2005) reported on discoveries made during monitoring of the macromycobiota of Veracruz, Mexico.

Hesler & Smith (1963), included *H. virescens* in section *Hygrocybe* of subgenus *Hygrophorus*. Both micromorphology (regular hymenophoral trama, slender basidia, pileipellis in a cutis) and macroscopic habit support placement of *Hygrophorus virescens* in *Hygrocybe*, according to current interpretations of the genus by Bon (1976), Pegler (1983), Singer (1986), Boertmann (1995), and Young & Wood (1997). In fact the species has been cited as '*Hygrocybe*' *virescens* both in the literature (Arora 1986, Cantrell & Lodge 2004, Montoya et al. 2005) and on numerous species lists and in mushroom club newsletters. According to the Index *Hygrocybearum* by Boertmann (2002), however, the transfer of the species to *Hygrocybe* has not been validly published yet.

In our previous publication (Montoya et al. 2005) where we reported our study of the type specimen, we neglected to note the absence of a combining

* Corresponding author

author in *Hygrocybe* and so improperly placed the species in this latter genus. In accordance with the rules of International Code of Botanical Nomenclature (McNeill et al. 2006), we propose the following combination:

***Hygrocybe virescens* (Hesler & A.H. Sm.) Montoya & Bandala comb. nov.**

MYCOBANK MB510600

Basionym: *Hygrophorus virescens* Hesler & A.H. Sm., N. Am. Sp. of *Hygrophorus*, p. 192, 1963.

Holotype: U.S.A. CALIFORNIA: Trinidad, 14.XI.1956, A.H. Smith 56649 (MICH).

Acknowledgements

We express our thanks to Drs. Lorelei Norvell (Mycotaxon Editor-in-Chief) and Shaun Pennycook (Mycotaxon Nomenclature Editor) for their advice in the preparation of the manuscript. We acknowledge the curator of MICH for the original loan of the type specimen.

Literature cited

- Arora D. 1986. Mushrooms Demystified. Ten Speed Press, 2nd ed. Berkeley, California, 959 pp.
- Boertmann D. 1995. The genus *Hygrocybe*. Fungi of Northern Europe 1. Danish Mycological Soc., Copenhagen, 184 pp.
- Boertmann D. 2002. Index *Hygrocybearum*. A catalogue to names and potential names in Tribus *Hygrocybeae* Kühner (*Tricholomatales*, *Fungi*). Stuttgart, J. Cramer - Bibliotheca Mycologica 192, 168 pp.
- Bon M. 1976. Clé monographique des *Hygrophoraceae* Roze. Doc. Myc. 7(25): 1-24.
- Cantrell SA, Lodge J. 2004. *Hygrophoraceae* (*Agaricales*) of the Greater Antilles: *Hygrocybe* subgenus *Pseudohygrocybe* sections *Coccineae* and *Neohygrocybe*. Mycol. Res. 108: 1301-1314.
- McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema JH. 2006. International Code of Botanical Nomenclature (Vienna Code) Regnum Vegetabile 146. Koeltz Scientific Books, Koenigstein.
- Hesler LR, Smith AH. 1963. North American species of *Hygrophorus*. Univ. Tennessee Press, Knoxville, Tennessee, 416 pp.
- Largent DL. 1985. The *Agaricales* (gilled fungi) of California 5. *Hygrophoraceae*. Mad River Press, Eureka, California, 209 pp. + 78 ph.
- Montoya L, Bandala VM, Jarvio D. 2005. New records of *Hygrocybe* from the Gulf of Mexico area. Mycotaxon 91: 471-480.
- Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Kew Bull. Add. Ser. 9. HMSO, London.
- Singer R. 1986. *Agaricales* in Modern Taxonomy. Koeltz Scientific Books, Koenigstein, 981 pp. + 88 pl.
- Young AM, Wood AE. 1997. Studies on the *Hygrophoraceae* (*Fungi*, *Homobasidiomycetes*, *Agaricales*) of Australia. Australian Systematic Botany 10: 911-1030.

Two new species of *Corynespora* from Guangdong, China

GUANG-MIN ZHANG & XIU-GUO ZHANG*

zhxg@sdau.edu.cn

Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—Two new species, *Corynespora tanacetii* on *Tanacetum vulgare* and *Corynespora scolopiae* on *Scolopia chinensis* are described.

Key words—hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on dead branches or rotten wood from south China revealed two previously undescribed species of *Corynespora* Güssow. The first species was collected from the Arboretum of Huanan in Guangdong. The specimens of dead branches or rotten wood were collected from subtropical localities of Guangdong province of China during 2005.

Taxonomic descriptions

Corynespora tanacetii Guang M. Zhang & X. G. Zhang, sp. nov.

FIGURE 1

MycoBank # MB 510542

Coloniae griseae vel fuscae, effusae. *Mycelium* partim superficiale et immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, levibus, 2–7 μm crassis compositum. *Stromata* nulla. *Conidiophora* singula, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 1–3 proliferationes percurrentes successivas cylindricae, 145–206 μm longa, 5–6 μm crassa. *Conidia* singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, laevia vel verrucosa, pallide brunnea vel olivaceo-brunnea, fere obclavata longe attenuata, recta vel curvata, 7–12-pseudoseptata, 60–104 μm longa, 12–16 μm lata. basi truncata 4–6.5 μm lata, apicem versus ad 2–3 μm attenuata.

Holotype: on dead branches of *Tanacetum vulgare* L., Arboretum of Huanan, Guangdong Province, China. Sept. 12. 2005, X. G. Zhang, HSAUPIV₀ 0022 (isotype: HMAS 143711).

Etymology: in reference to the host, *Tanacetum vulgare*.

* Corresponding author

Colonies grey to dark blackish brown, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled, 2-7 μm thick hyphae. No stromata. Conidiophores arising singly, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 3 successive percurrent cylindrical proliferations, $145\text{--}206 \times 5\text{--}6 \mu\text{m}$. Conidia formed singly through a pore at the apex of the conidiophore which then proliferates through the apical pore and forms another conidium at the apex of the proliferation, smooth or verruculose, pale brown to olivaceous brown, usually obclavate tapering to the narrow apex, straight or obviously curved, 7-12-pseudosepta, 60-104 μm long, 12-16 μm thick, 4.0-6.5 μm wide at the truncate base, tapering to 2-3 μm near the apex. Lower cells dark brown, upper cells becoming gradually paler toward the apex.

The new species differs from *C. foveolata* (Hughes 1958) in its wider conidia (12-16 μm). In addition, the conidiophores of the new species have only 1-3 successive proliferations, while those of *C. foveolata* have up to 7.

Corynespora scolopiae Guang M. Zhang & X.G. Zhang, sp. nov.

FIGURE 2

Mycobank # MB 510543

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2-6 μm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, 3-10-septata, per usque ad 1-2 proliferationes percurrentes successivas cylindricas elongascentia, 125-130 μm longa, 4-6 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevia, pallide brunnea vel brunnea, 8-11-pseudoseptata, 90-173 μm longa, 10-13 μm crassa, apicem versus ad 2-3 μm attenuata.

Holotype: on dead branches of *Scolopia chinensis* (Lour.) Clos., Arboretum of Huanan, Guangdong Province, China. Sept. 12. 2005, X. G. Zhang, HSAUP IV₀0084-2 (isotype: HMAS 143712).

Etymology: in reference to the host, *Scolopia chinensis*.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2-6 μm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, 3-10-septate, with up to 2 successive percurrent cylindrical proliferations, $125\text{--}130 \times 4\text{--}6 \mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or curved, obclavate, tapering to the apex, smooth-walled, pale brown to brown, 8-11-pseudosepta, 90-150 μm long, 10-13 μm thick in the broadest part, tapering to 2-3 μm near the apex. Lower cells slightly darker brown, upper cells becoming gradually paler toward the apex.

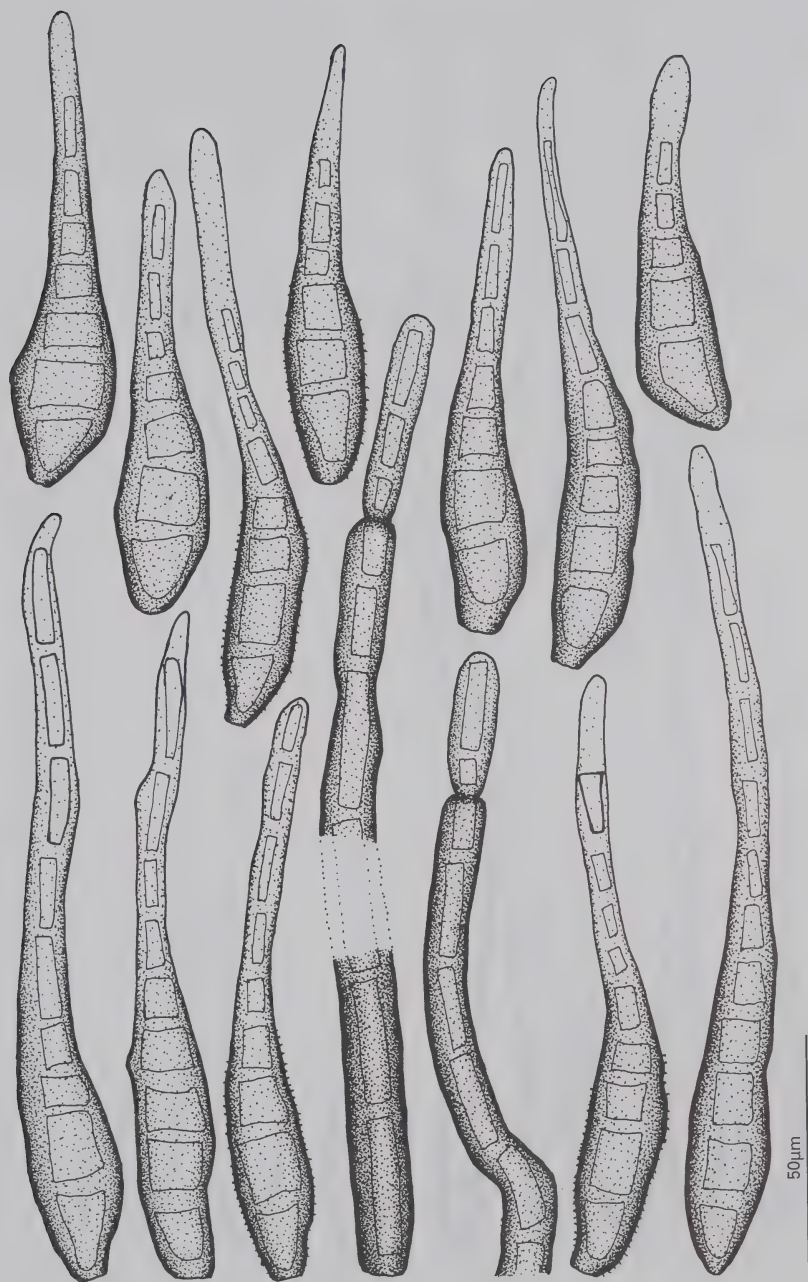


Fig. 1 Conidia and conidiophores of *C. tanacetii*

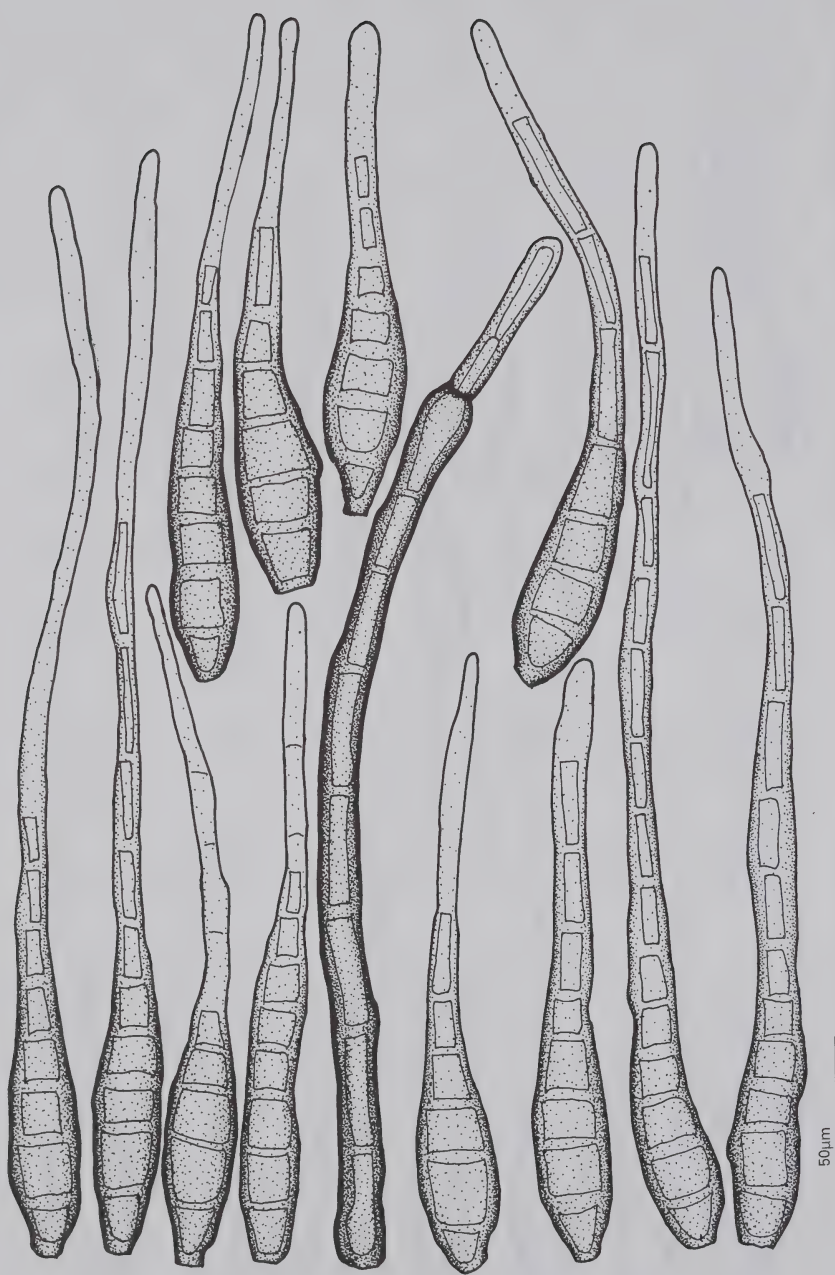


Fig. 2 Conidia and conidiophores of *C. scolopiae*

With respect to conidial morphology, this species resembles *C. tectonae* (Zhang & Shi 2005) and *C. sacchari* (Zhang & Shi 2005). However, the conidia of the new taxon have only 8-11-pseudosepta, while those of *C. tectonae* and *C. sacchari* have 12-18-pseudosepta and 10-14-septa, respectively. In addition, the conidia of the new taxon are smooth-walled, as opposed to those of *C. tectonae* and *C. sacchari*, which are often verrucose.

Acknowledgments

The authors are indebted to B. Kendrick and N. R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (No. 30370009, 30499340).

Literature cited

- Hughes SJ. 1958. Revisiones Hyphomycetes aliquot cum appendice de nominibus rejiciendis. Canadian Journal of Botany 36 : 727-836.
- Zhang XG, Shi CHK. 2005. Taxonomic studies of *Corynespora* from China. Mycotaxon 92 : 417-423.

Three new species of *Corynespora* from China

JIAN MA & XIU-GUO ZHANG*

Zhxcg@sdaa.edu.cn

Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—This paper provides descriptions and illustrations for three new species of the hyphomycete genus *Corynespora* from dead branches in south of China. *C. gymnocladi*, *C. myrioneuronis* and *C. euryae* occurred on *Gymnocladus chinensis*, *Myrioneuron faberi* and *Eurya inaequalis*, respectively. The type specimens are deposited in the Herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP).

Key words—hyphomycetes, dematiaceous

Introduction

This study revealed three previously undescribed species of *Corynespora* Güssow on dead branches in subtropical localities in Sichuan, Guizhou and Yunnan Provinces of China.

Taxonomic Description

Corynespora gymnocladi Jian Ma & X. G. Zhang, sp. nov.

FIGURE 1

MYCOBANK # MB 510534

Coloniae fuscae vel atrae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-5 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel atro-brunnea, per usque ad 2 proliferationes successivas cylindricas elongascentia, 60-145 µm longa, 3.8-5.7 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leniter curvata, obclavata, laevia, brunnea vel atro-brunnea, cellulis extimis subhyalinis vel pallide brunneis, 2-6-pseudoseptata, 15-40 µm longa, 7-10.5 µm crassa, basi 1.5-3 µm lata.

Holotype: on dead branches of *Gymnocladus chinensis* Baill, subtropical forest of Yaan, Sichuan Province, China. Aug. 12. 2005, J. Ma, HSAUPV_{0MJ} 0369.

Etymology: in reference to the host, *Gymnocladus chinensis*

* Corresponding author

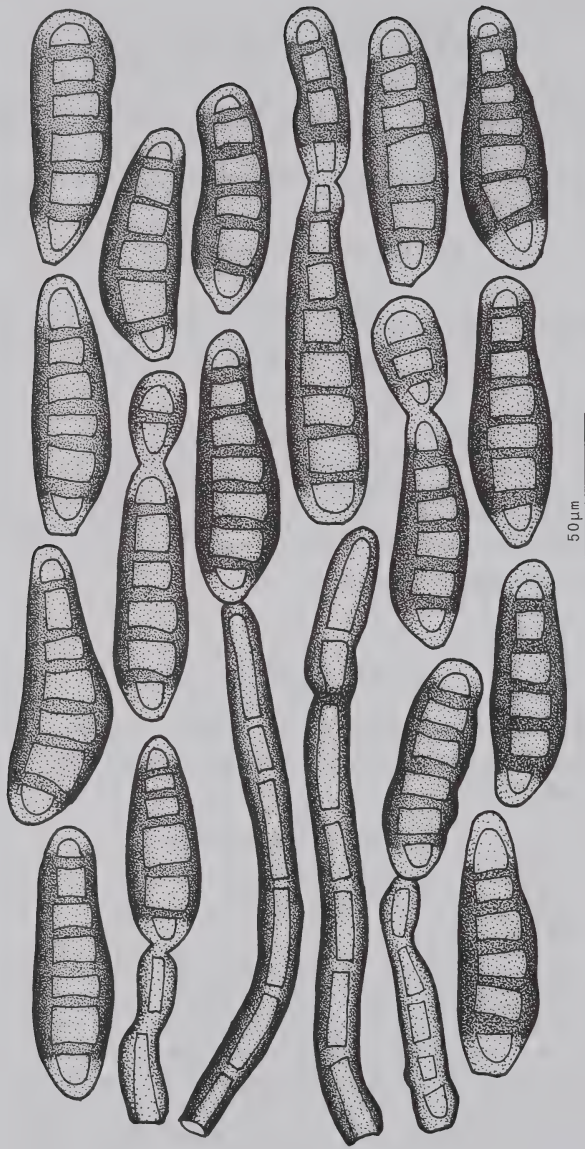


Fig. 1 Conidia and conidiophores of *C. gymnocladi*

Colonies dark blackish brown to black, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-5 μm thick. Stroma absent. Conidiophores arising singly

or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to dark brown, with up to 2 successive percurrent cylindrical proliferations, $60\text{--}145 \times 3.8\text{--}5.7\ \mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or slightly curved, obclavate, smooth-walled, brown to dark brown except for the cell at each end which is subhyaline or pale brown, 2-6-pseudoseptate, $15\text{--}40\ \mu\text{m}$ long, $7\text{--}10.5\ \mu\text{m}$ thick in the broadest part, $1.5\text{--}3\ \mu\text{m}$ wide at the base.

The conidia of *Corynespora gymnocladi* are similar to those of *C. lanneicola* (Deighton & Ellis 1957), but are smaller. In addition, conidia of this new species have a much less obvious truncate basal scar than the species of *C. lanneicola*.

***Corynespora myrioneuronis* Jian Ma & X. G. Zhang, sp. nov.**

MYCOBANK # MB 510535

FIGURE 2

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-4 μm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 3 proliferationes successivas cylindricas elongascentia, $92\text{--}120\ \mu\text{m}$ longa, $3.5\text{--}5\ \mu\text{m}$ crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leniter curvata, obclavata, laevia, pallide brunnea vel brunnea, 3-4-pseudoseptata, $30\text{--}46\ \mu\text{m}$ longa, $6.5\text{--}8\ \mu\text{m}$ crassa, apicem versus ad $2\text{--}3.5\ \mu\text{m}$ attenuata, basi $2\text{--}3\ \mu\text{m}$ lata.

Holotype: on dead branches of *Myrioneuron faberi* Hemsl, Arboretum of Guiyang, Guizhou Province, China. Aug. 18. 2005, J. Ma, HSAUPV0MJ 0451.

Etymology: in reference to the host, *Myrioneuron faberi*

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, $2\text{--}4\ \mu\text{m}$ thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 3 successive percurrent cylindrical proliferations, $92\text{--}120 \times 3.5\text{--}5\ \mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or slightly curved, obclavate, smooth-walled, pale brown to brown, 3-4-pseudoseptate, $30\text{--}46\ \mu\text{m}$ long, $6.5\text{--}8\ \mu\text{m}$ thick in the broadest part, tapering to $2\text{--}3.5\ \mu\text{m}$ near the apex, $2\text{--}3\ \mu\text{m}$ wide at the base.

The conidia of *Corynespora myrioneuronis* are smaller than those of *C. ligustri* (Guo 1984) and *C. eranthemi* (Yen & Lim 1980), and the mature conidia of *C. myrioneuronis* have fewer pseudosepta (3-4) than those of *C. ligustri* (4-20) and *C. eranthemi* (5-25). In addition, the conidiophores of the new species have only 1-3 successive proliferations, while those of *C. ligustri* and *C. eranthemi* have up to 16 and 8, respectively.

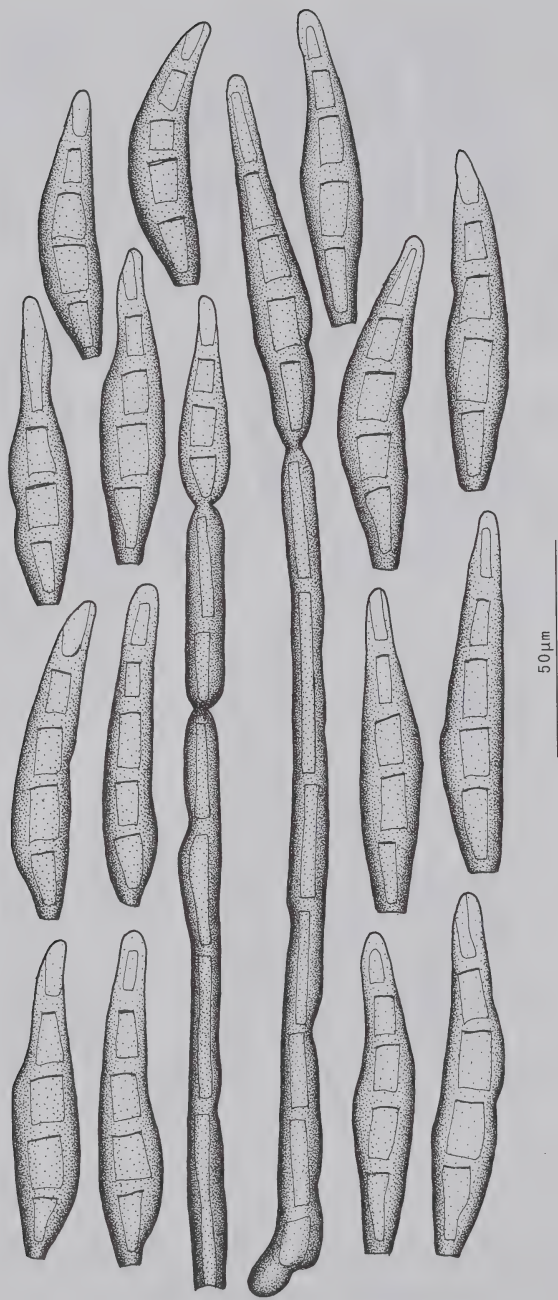


Fig. 2 Conidia and conidiophores of *C. myrioneuronis*

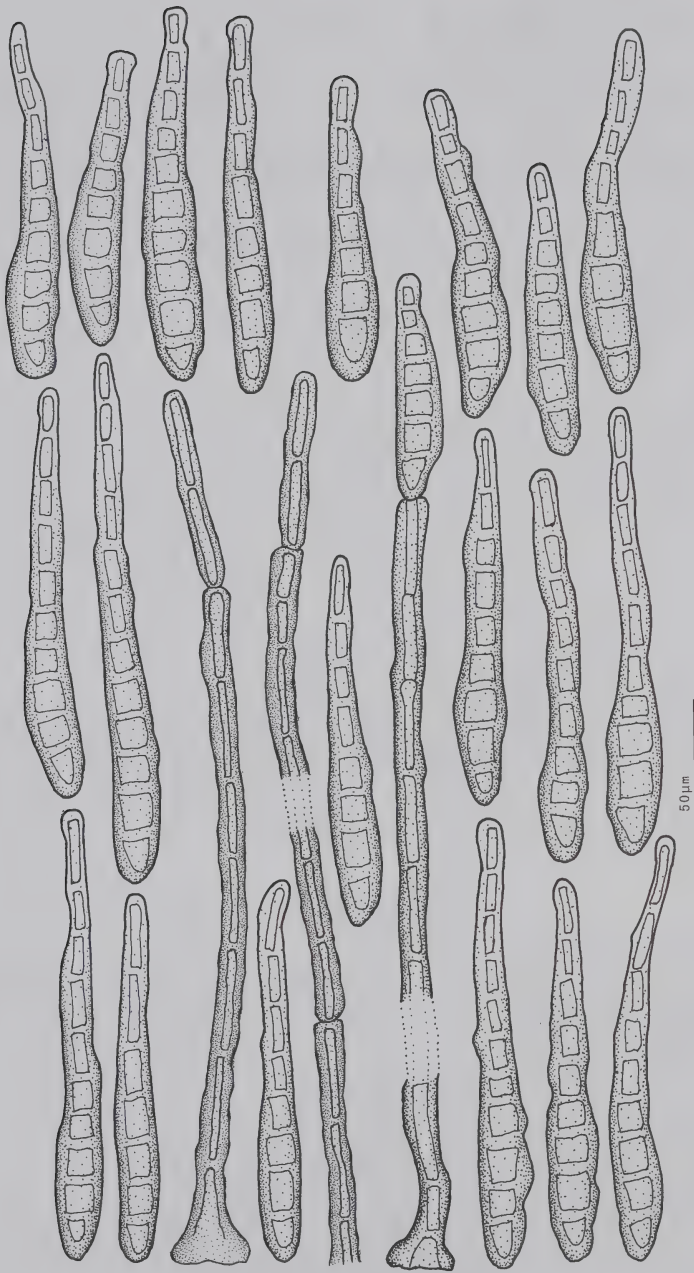


Fig. 3 Conidia and conidiophores of *C. euryae*

***Corynespora euryae* Jian Ma & X. G. Zhang, sp. nov.**

FIGURE 3

MYCOBANK # MB 510536

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-6 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 4 proliferationes successivas cylindricas elongascentia, 76-114 µm longa, 3.5-5.5 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda. Conidia recta vel leniter curvata, obclavata, laevia, pallide brunnea vel brunnea, 5-9-pseudoseptata, 36-67 µm longa, 6-9 µm crassa, apicem versus ad 2.5-4 µm attenuata, basi 2-3 µm lata.

Holotype: on dead branches of *Eurya inaequalis* P.S. Hsu, tropical forest of Hekou, Yunnan Province, China. Oct. 16, 2004, J. Ma, HSAUPIV0MJ 0144.

Etymology: in reference to the host, *Eurya inaequalis*

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-6 µm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 4 successive percurrent cylindrical proliferations, 76-114×3.5-5.5 µm. Conidia formed singly through a pore at the apex of the conidiophore or through the apices of successive percurrent proliferations. Conidia straight or slightly curved, obclavate, smooth-walled, pale brown to brown, 5-9-pseudoseptate, 36-67 µm long, 6-9 µm thick in the broadest part, tapering to 2.5-4 µm near the apex, 2-3 µm wide at the base.

Lower cells brown, upper cells becoming gradually paler toward the apex.

The new species of *Corynespora euryae* differs from *C. combrei* (Ellis 1963) and *C. hansfordii* (Ellis 1960) in the smaller size range of its conidia. In addition, conidia of the new species have a much less obvious truncate scar at the base than those of the other two well-known species.

Acknowledgments

The authors are indebted to W.B. Kendrick and B. Le Cam for serving as pre-submission reviewers and for their valuable comments and suggestions. This study would not have been possible without support from the National Natural Science Foundation of China (no. 30370009, 30499340).

Literature Cited

- Ellis MB. 1957. Some species of *Corynespora*. Mycological Papers 65: 1-15.
 Ellis MB. 1960. Dematiaceous Hyphomycetes I. Mycological Papers 76: 1-36.
 Ellis MB. 1963. Dematiaceous Hyphomycetes IV. Mycological Papers 87: 39-42.
 Guo YL. 1984. Four new species of the genus *Corynespora*. Acta Mycologica Sinica 3(3): 161-169.
 Yen JM, Lim G. 1980. Etude sur les champignons parasites du sud-est asiatique XXIX. - Les *Corynespora* de Malaisie. Cryptogamie Mycologie 1(1): 83-90.

Taxonomic studies of *Sporidesmium* from Guangxi, China

CHENG-KUI SHI & XIU-GUO ZHANG*

zhxg@sdaa.edu.cn

*Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—This paper provides descriptions and illustrations of four new species in the hyphomycete genus *Sporidesmium* from deciduous stems or rotten wood. *S. delavayae*, *S. tarennae*, *S. phoebes* and *S. ochnae* occurred on the hosts *Delavaya toxocarpa*, *Tarenna acutisepala*, *Phoebe rufescens* and *Ochna jabotapita*, respectively. One new record is illustrated from the same area.

Key words—hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on deciduous stems or rotten wood from the Yulin forest of Guangxi province in south China revealed four previously undescribed species of *Sporidesmium* Link. One other species new to China was found.

Taxonomic Description

Sporidesmium delavayae Ch. K. Shi & X. G. Zhang, sp. nov.

FIGURE 1

MYCOBANK # MB 510537

Coloniae griseae vel fuscae, effusae. *Mycelium* immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2–5 μm crassis, compositum. *Conidiophora* singula ex apice lateribusque hypharum oriunda, simplicia, recta vel flexuosa, brunnea vel atro-brunnea, cylindrica, 3–5-septata, laevia, per usque ad 2–3 proliferationes successivas elongascentia, 80–130 μm longa, 5–8 μm crassa. *Conidia* singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leviter flexuosa, fusiformia, ad apicem subacuta vel conica, ad basim conico-truncata, laevia, brunnea vel olivaceo-brunnea, sursum pallidiora, 5–7-pseudoseptata, 35–45 μm longa, 12–15 μm crassa, apicem versus ad 3–4 μm attenuata, basi 5–8 μm lata.

Holotype: on dead branches of *Delavaya toxocarpa* Franch., Subtropical forest of Yulin, Guangxi Province, China. Oct. 20. 2003, X. G. Zhang, HSAUP III₀zxcg0046-2.

Etymology: referring to the host, *Delavaya toxocarpa*.

* Corresponding author

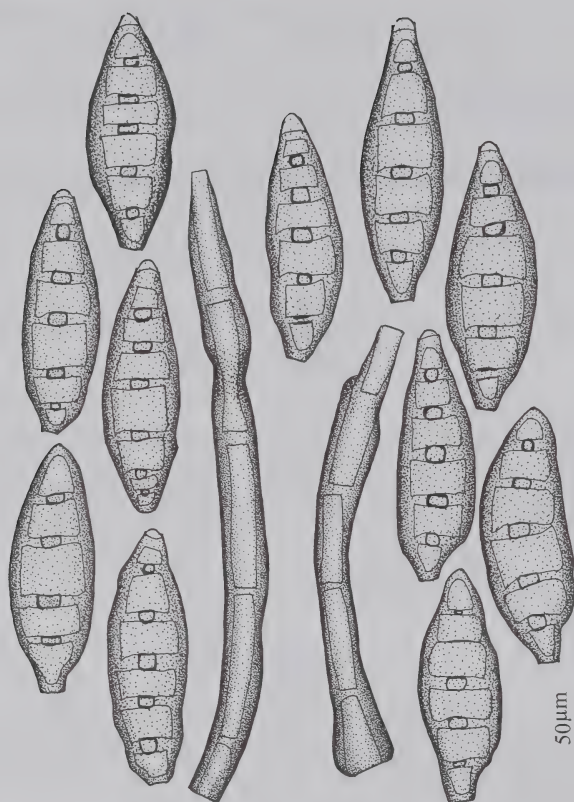


Fig. 1 Conidia and conidiophores of *S. delavayae*

Colonies grey to dark blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-5 μm thick. Conidiophores arising singly, terminally and laterally on the hyphae, erect, simple, straight or flexuous, mid to dark brown, cylindrical, 3-5-septate, smooth-walled, with up to 2-3 successive percurrent proliferations; 80-130 μm long, 5-8 μm thick. Conidia formed singly at the apex of the conidiophore, straight or flexuous, fusiform, subacute or conical at the apex, conico-truncate at the base, smooth-walled, brown to olivaceous brown, paler at the tip, 5-7-pseudoseptate, 35-45 μm long, 12-15 μm thick in the widest part, tapering to 3-4 μm near the apex, 5-8 μm wide at the base, pseudosepta averaging 7.5 μm apart.

In conidial morphology, this species resembles *S. leonense* (Ellis 1958). However, the new taxon can be separated from *S. leonense* by its shorter conidia with less

numerous pseudosepta. In addition, some conidia of *S. leonense* are rostrate, while those of the new species are not.

***Sporidesmium tarennae* Ch. K. Shi & X. G. Zhang, sp. nov.**

FIGURE 2

Mycobank # MB 510538

Coloniae griseae vel fuscae, effusae. *Mycelium* immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 3-6 μm crassis, compositum. *Conidiophora* singula ex apice lateribusque hypharum oriunda, simplicia, recta vel flexuosa, brunnea vel atro-brunnea, cylindrica, 4-6-septata, laevia, per usque ad 3 proliferationes successivas elongascentia, 50-120 μm longa, 4-6 μm crassa. *Conidia* singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, fusiformia, rostrata, ad apicem subacuta vel conica, ad basim conico-truncata, laevia, straminea vel flavo-brunnea, sursum pallidiora, 6-7-pseudoseptata, 45-50 μm longa, 12-15 μm crassa, apicem versus ad 2-3.5 μm attenuata, basi 4-5 μm lata.

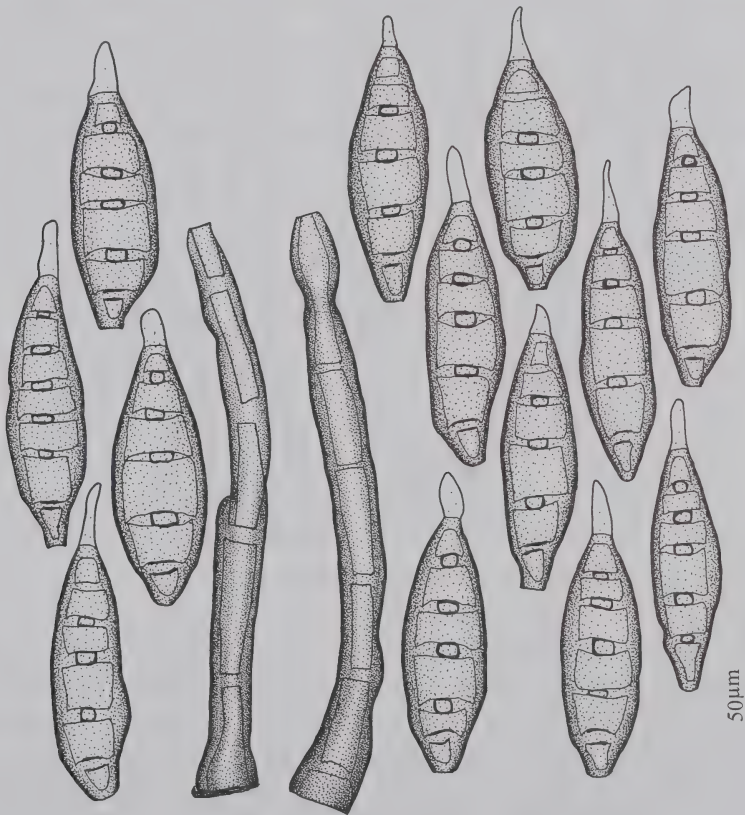


Fig. 2 Conidia and conidiophores of *S. tarennae*

Holotype: on dead branches of *Tarenna acutisepala* W. C. Chen., Subtropical forest of Yulin, Guangxi Province, China. Oct. 20. 2003, X. G. Zhang, HSAUPIII₀zxc0113.

Etymology: in reference to the host, *Tarenna acutisepala*.

Colonies grey to dark blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 3-6 μm thick. Conidiophores arising singly, terminally and laterally on the hyphae, erect, simple, straight or flexuous, mid to dark brown, cylindrical, 4-6-septate, smooth-walled, with up to 3 successive percurrent proliferations; 50-120 μm long, 4-6 μm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly curved, fusiform, rostrate, subacute or conical at the apex, conico-truncate at the base, smooth-walled, straw coloured to yellowish, paler at the tip, 6-7-pseudosepta, 45-50 μm long, 12-16 μm thick in the widest part, tapering to 2-3.5 μm near the apex, 4-5 μm wide at the base, pseudosepta averaging 10.8 μm apart.

The conidia of this species are similar to those of *S. leonense* (Ellis 1958) and *S. brachypus* (Hughes 1958). However, the conidia in the new taxon are shorter (40-45 μm) than those of *S. leonense* (45-90 μm) and *S. brachypus* (50-90 μm). In addition, the rostrate of the new taxon conidia are also somewhat longer than those of *S. leonense* and obviously shorter than those of *S. brachypus*.

***Sporidesmium phoebes* Ch. K. Shi & X. G. Zhang, sp. nov.**

FIGURE 3

MYCOBANK # MB 510539

Coloniae griseae vel fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 3-6 μm crassis, compositum. Conidiophora singula ex apice lateribusque hypharum oriunda, simplicia, recta vel flexuosa, brunnea vel atro-brunnea, cylindrica, 5-7-septata, laevia, per usque ad 1-2 proliferationes successivas elongascentia, 50-100 μm longa, 5-7 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, fusiformia, rostrata, ad apicem subacuta vel conica, ad basim truncata, laevia, brunnea vel atro-brunnea, sursum pallidiora, 6-7-pseudoseptata, 50-65 μm longa, 15-18 μm crassa, apicem versus ad 3-4 μm attenuata, basi 2-4 μm lata.

Holotype: on dead branches of *Phoebe rufescens* H. W. Li., Subtropical forest of Yulin, Guangxi Province, China. Oct. 10. 2004, X. G. Zhang, HSAUPIV₀zxc0111.

Etymology: in reference to the host, *Phoebe rufescens*.

Colonies grey to dark blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 3-6 μm thick. Conidiophores arising singly, terminally and laterally on the hyphae, erect, simple, straight or flexuous, mid to dark brown, cylindrical, 5-7-septate, smooth-walled, with up to 1-2 successive percurrent proliferations; 50-100 μm long, 5-7 μm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly curved, fusiform, rostrate, subacute or conical at the apex, truncate at the base, smooth-walled, mid to dark brown,

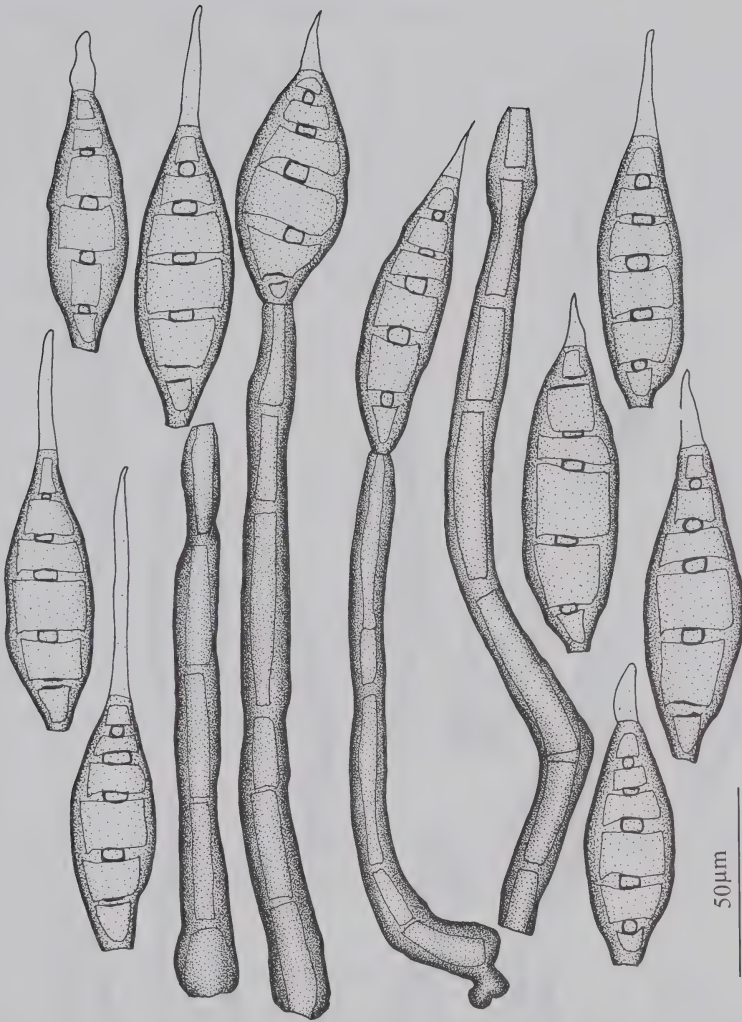


Fig.3 Conidia and conidiophores of *S. phoebes*

paler at the tip, 6-7-pseudoseptate, 50-65 μm long, 15-18 μm thick in the widest part, tapering to 3-4 μm near the apex, 2-4 μm wide at the base, pseudosepta averaging 5.3 μm apart.

The conidia of *Sporidesmium phoebes* are similar to those of *S. brachypus*, but the conidia are shorter than those of *S. brachypus* (50-90 μm), and of wider than those of *S. brachypus* (10-14 μm). In addition, conidia of the new species have lighter truncate scar at the base than in *S. brachypus*.



Fig.4 Conidia and conidiophores of *S. ochnae*

***Sporidesmium ochnae* Ch. K. Shi & X. G. Zhang, sp. nov.**

FIGURE 4

MYCOBANK # MB 510541

Coloniae tenue effusae, brunneae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-4 µm crassis, compositum. Conidiophora singula ex apice lateribusque hypharum oriunda, simplicia, recta vel flexuosa, brunnea vel atro-brunnea, cylindrica, 2-3-septata, laevia, per usque ad 1-2 proliferationes successivas elongascentia, 45-65 µm longa, 4-5 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, rostrata, ad apicem subacuta vel conica, ad basim truncata, laevia, brunnea vel atro-brunnea, sursum pallidiora, 8-11-pseudoseptata, 80-110 µm longa, 10-12 µm crassa, apicem versus ad 2-3 µm attenuata, basi 4-6 µm lata.

Holotype: on dead branches of *Ochna jabotapita* L., Subtropical forest of Yulin, Guangxi Province, China. Oct. 16. 2003, X. G. Zhang, HSAUIII_zxg0499.

Etymology: in reference to the host, *Ochna jabotapita*.

Colonies effused, thin, pale brown. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 µm thick. Conidiophores arising singly, terminally and laterally on the hyphae, erect, simple, straight or flexuous, mid to dark brown, cylindrical, 2-3-septate, smooth-walled, with up to 1-2 successive percurrent proliferations; 45-65 µm long, 4-5 µm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly curved, obclavate, rostrate, subacute or conical at the apex, truncate at the base, smooth-walled, mid to dark brown, paler at the tip, 8-11-pseudoseptate, 80-110 µm long, 10-12 µm thick in the widest part, tapering to 2-3 µm near the apex, 4-6 µm wide at the base, pseudosepta averaging 7.2 µm apart.

The conidia of *Sporidesmium ochnae* are similar to those of *S. ellisii* (Ellis 1972), but their size range is larger than that of *S. ellisii* (40-90×7-9 µm). In addition, the mature conidia of *S. ochnae* have more numerous pseudoseptate than those of *S. ellisii*.

New record from China

Sporidesmium brachypus (Ellis & Everh.) S. Hughes, Can. J. Bot. 36: 807, 1958.

On rotten wood of *Canarium tonkinense* Engl., subtropical forest of Yulin, Guangxi Province, China. Oct. 12. 2004, X. G. Zhang, HSAUPIV_zxg0174.

Acknowledgments

The authors are indebted to B. Kendrick and N. R. O' Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (No. 30370009, 30499340).

Literature cited

- Ellis MB. 1958. *Clasterosporium* and some allied dematiaceae-phragmosporae. I. Mycological Papers 70 : 1-89.
- Ellis MB. 1972. Microfungi of Tanzania, I. Miscellaneous fungi on oil palm, II. New hyphomycetes. Mycological Papers 129 : 1-39.
- Hughes SJ. 1958. Revisiones Hyphomycetum aliquot cum appendice de nominibus rejiciendis. Canadian Journal of Botany 36 : 727-836.

Taxonomic studies of *Sporidesmium* from China

JIAN MA & XIU-GUO ZHANG *

Zhxg@sdaa.edu.cn

Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—Two new species of *Sporidesmium* from China are described and illustrated: *S. ilicis* and *S. pruni* occurring on the hosts *Ilex diphylla* and *Prunus pseudocerasus*, respectively. The type specimens are deposited in the Herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP).

Key words—hyphomycetes, dematiaceae

Introduction

The genus *Sporidesmium* was established by Link in 1809. The current generic concept is based on descriptions given by Ellis (1958, 1971) who based his account on Ehrenberg's description of the specimen in Persoon's herbarium at Leiden labeled by Ehrenberg '*Sporidesmium fusiforme* Nees ab Essen. - *Sporidesmium atrum* Link var. teste Link', Ellis (1958) pointed out: 'Link almost certainly saw a part of this specimen; and in the absence of the type or any authentic collection of *S. atrum* it serves to indicate the characters upon which he based his genus *Sporidesmium*', and precisely defined the distinctive features of the genus. *Sporidesmium* is characterized by single phaeophragmospores borne terminally on macronematous, mononematous, simple conidiophores with monoblastic, integrated, terminal, determinate or percurrently extending conidiogenous cells, and curved or occasionally sigmoid, cylindrical, fusiform, obclavate, obpyriform or obturbinate, solitary conidia.

The genus *Sporidesmium* contains about 320 species described from all over the world. Only 37 species have previously been described from China (Wu & Zhuang 2005). Most of these species are reported to survive saprophytically on rotten wood, dead branches, and decaying leaves of various plant species. A recent investigation of fungi occurring on dead branches from tropical or subtropical zones revealed two previously undescribed species of *Sporidesmium*.

* Corresponding author

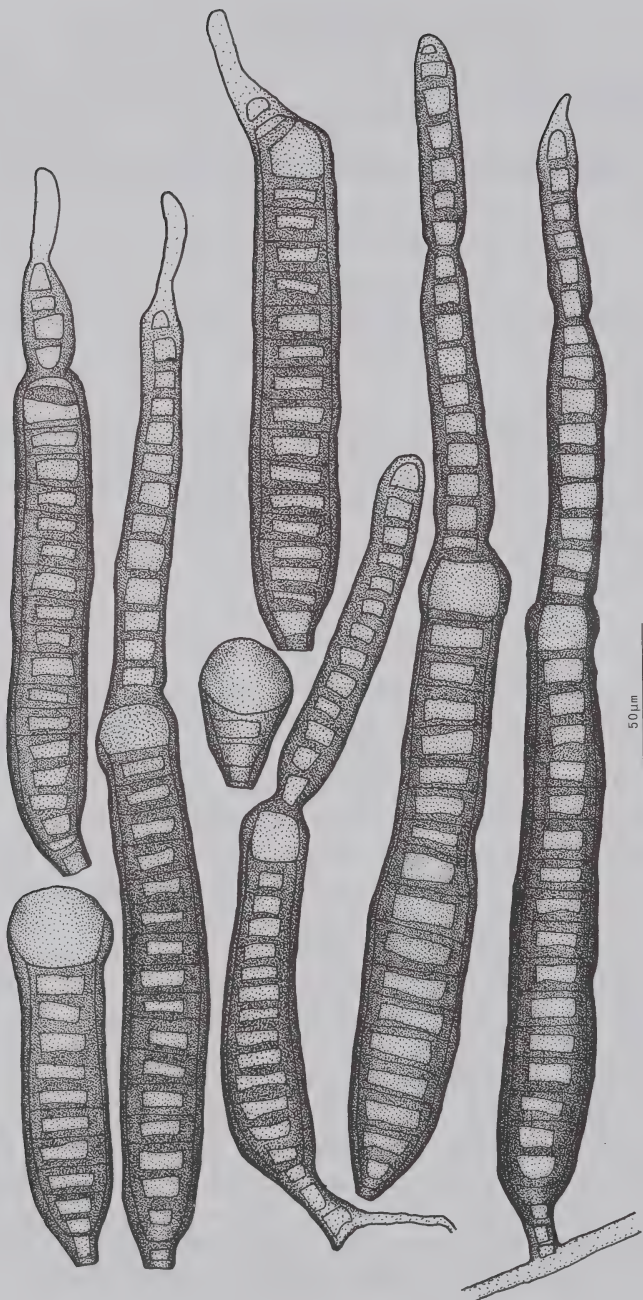


Fig. 1 Conidia and conidiophores of *S. ilicis*

Taxonomic description

Sporidesmium ilicis Jian Ma & X. G. Zhang, sp. nov.

FIGURE 1

MYCOBANK # MB 510532

Coloniae effusae, atrae. Mycelium immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus, 1-3 μm crassis compositum. Conidiophora singula vel fasciculata ex apice lateribusque hypharum oriunda, recta vel leviter flexuosa, brunnea vel atro-brunnea, 1-2-septata, 4.5-12.5 μm longa, 4.5-6 μm crassa. Conidia singula in apice conidiophori oriunda, recta vel flexuosa, obclavata, ornati cellula medius tumescente usque ad 13.6 μm crassa et 9.2 μm alta, usque ad 10.5 μm crassi immediate supra cellulam medius tumescentem, aliquando basi vel apice, interdum apice longe attenuata, ad basim conico-truncata, levia, brunnea, 10-38-pseudoseptata, 70-215 μm longa, 13-19.5 μm crassa, apicem versus ad 5-8 μm attenuata, basi 5-6.5 μm lata.

Holotype: on dead branches of *Ilex dipyrena* Wall., tropical forest of Lijiang, Yunnan Province, China. May. 6. 2005, J. Ma, HSAUPV_{OMJ} 0008(4).

Etymology: in reference to the host, *Ilex dipyrena*

Colonies effused, black. Mycelium immersed in the substratum, composed of branched and anastomosing, septate, pale brown, smooth-walled hyphae, 1-3 μm thick. Conidiophores arising singly or in groups at the ends and along the sides of the hyphae, sometimes from darker, swollen cells, straight or slightly flexuous, mid to dark brown, 1-2-septate, 4.5-12.5 μm long, 4.5-6 μm thick. Conidia formed singly at the apex of the conidiophores, straight or flexuous, obclavate, with a swollen mid cell up to 13.6 $\times$ 9.2 μm in size, up to 10.5 μm thick immediately above the swollen mid cell, occasionally at the base or apex, sometimes tapered towards the rounded apex, conico-truncate at the base, smooth-walled, brown, 10-38-pseudoseptate, 70-215 μm long, 13-19.5 μm thick in the widest part, tapering to 5-8 μm at the apex, 5-6.5 μm wide at the base, pseudosepta averaging 5.7 μm apart.

The conidia of *Sporidesmium ilicis* are similar to those of *S. adscendens* (Ellis 1958). However, the conidia in the new taxon (70-215 μm) are shorter than those of *S. adscendens* (110-375 μm). In addition, the conidia of the new taxon are rounded or rostrate at the apex, and have swollen central cells, as opposed to those of *S. adscendens*, which are rounded at the apex and have no swollen cells.

Sporidesmium pruni Jian Ma & X. G. Zhang, sp. nov.

FIGURE 2

MYCOBANK # MB 510533

Coloniae effusae, fuscae vel atrae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, levibus, 1-4 μm crassis compositum. Conidiophora singula vel 2-3 fasciculata ex apice lateribusque hypharum oriunda, erecta vel suberecta, recta vel leviter flexuosa, cylindrica, ad apicem conico-truncata, basi inflata, brunnea vel atro-brunnea, 2-5-septata, per usque ad 2 proliferationes successivas elongascentia, 50-85 μm longa, 3-6 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leviter curvata,

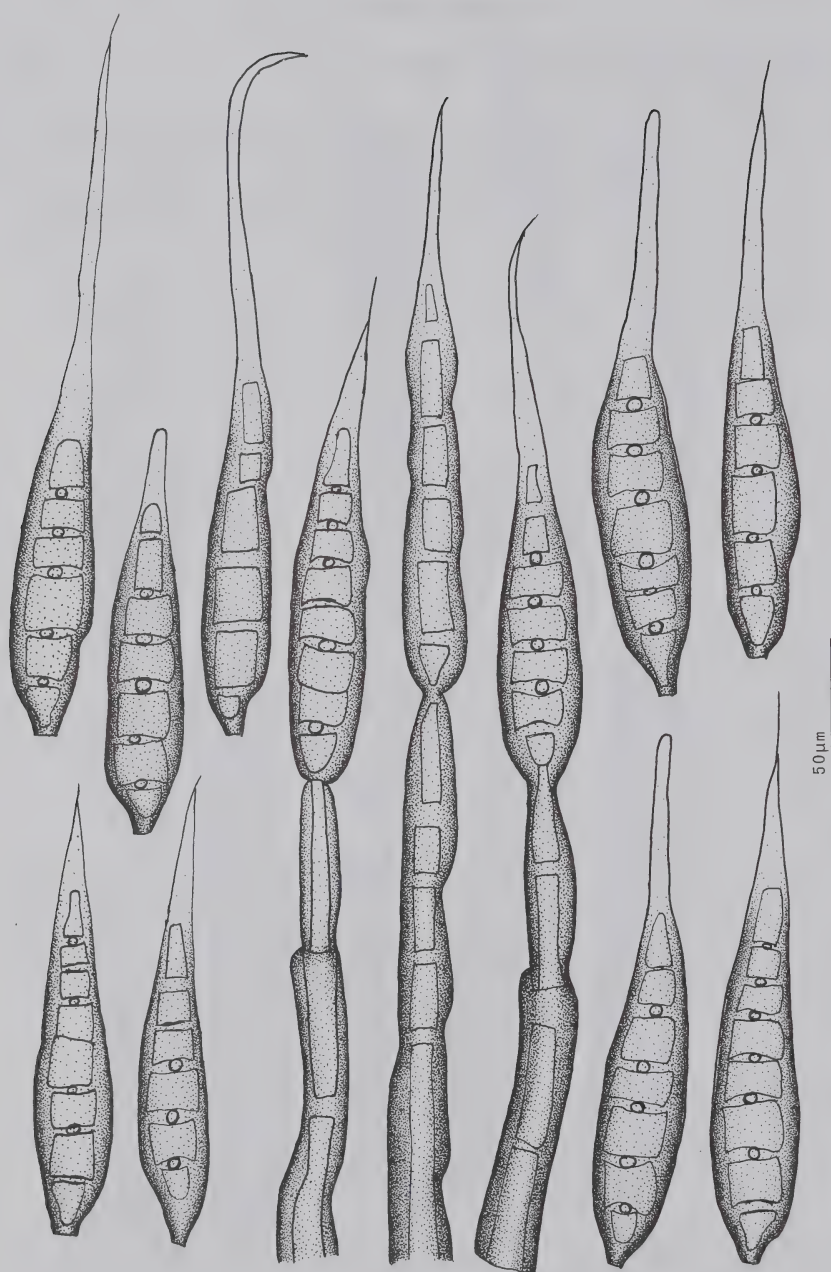


Fig. 2 Conidia and conidiophores of *S. pruni*

fusiformia, rostrata, ad basim conico-truncata, levia, straminea vel olivaceo-brunnea, 5-8-pseudoseptata, 45-87 µm longa, 8.5-10.5 µm crassa, apicem versus ad 2.5-3.5 µm attenuata, basi 2-3.6 µm lata.

Holotype: on dead branches of *Prunus pseudocerasus* Lindl, Arboretum of Mianyang, Sichuan Province, China. Aug. 10. 2005, J. Ma, HSAUPV_{0M} 0539(1).

Etymology: in reference to the host, *Prunus pseudocerasus*

Colonies effused, dark blackish brown to black. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 1-4 µm thick. Conidiophores arising singly or in groups of 2-3 terminally and laterally on the hyphae, erect or suberect, straight or slightly flexuous, cylindrical, conico-truncate at the apex, with a swollen base, brown or dark brown, 2-5-septate, with up to 2 successive proliferations, 50-85 µm long, 3-6 µm thick. Conidia formed singly at the apex of the conidiophore which after the first conidium has fallen sometimes proliferates through the scar and forms another conidium at the apex of the proliferation. Conidia straight or slightly curved, fusiform, rostrate, conico-truncate at the base, smooth-walled, straw coloured to olivaceous brown, 5-8-pseudoseptate, 45-87 µm long, 8.5-10.5 µm thick in the widest part, tapering to 2.5-3.5 µm near the apex, 2-3.6 µm wide at the base, pseudosepta averaging 5.6 µm apart.

The conidia of this species are similar to those of *S. brachypus* (Hughes 1958). However, the conidia of the new taxon are narrower (8.5-10.5 µm) than those of *S. brachypus* (10-14 µm). In addition, the conidiophores of the new species have only 1-2 successive proliferations, while those of *S. brachypus* have up to 4.

Acknowledgments

The authors are indebted to W. B. Kendrick and B. Le Cam for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (no.30370009, 30499340).

Literature Cited

- Ellis MB. 1958. *Clasterosporium* and some allied *Dematiaceae* – *Phragmosporae*. I. Mycological Papers 70: 1-89.
- Ellis MB. 1971. *Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute, Kew, Surrey, England. 116-122.
- Hughes SJ. 1958. Revisions *Hyphomycetes* aliquot cum appendice de nominibus rejiciendis. Canadian Journal of Botany 36: 727-836.
- Wu WP, Zhuang WY. 2005. *Sporidesmium*, *Endophragmiella* and related genera from China. Fungal Diversity Research Series 15: 1-351.

NOMENCLATURAL NOVELTIES PROPOSED IN MYCOTAXON 99

- Alternaria astragali* Wangeline & E.G. Simmons, p. 84
Alternaria dissitiflora Meng. Zhang & T. Y. Zhang, p. 135
Alternaria polygoni Meng. Zhang & T. Y. Zhang, p. 133
Alternaria seleniiphila Wangeline & E.G. Simmons, p. 86
Anthracoidea setschwanensis L. Guo, p. 227
Antrodiella semistipitata Bernicchia & Ryvarden, page 232
Campanella gregaria Bougher, p. 328
Cercospora habenariicola Meeboon, Hidayat & C. Nakash., p. 118
Corynespora euryae Jian Ma & X.G. Zhang, p. 358
Corynespora gymnocladi Jian Ma & X.G. Zhang, p. 353
Corynespora myrioneuronis Jian Ma & X.G. Zhang, p. 355
Corynespora scolopiae Guang M. Zhang & X. G. Zhang, p. 348
Corynespora tanacetii Guang M. Zhang & X. G. Zhang, p. 347
Curvularia graminis Meng Zhang & T.Y. Zhang, p. 145
Curvularia pseudorobusta Meng Zhang & T. Y. Zhang, p. 143
Dactylella vermiformis Z.F. Yu, Ying Zhang & K.Q. Zhang, p. 275
Doassansiopsis limnanthemii (Cif.) Vánky, p. 28
Entyloma heterothecae Vánky, p. 46
Erysiphe yanshanensis T.Z. Liu & U. Braun, p. 76
Franzpetrakia phaceluri Vánky, R.G. Shivas & L. Guo, p. 41
Fuscopannaria caribbea Øvstedal, p. 92
Genea balsleyi M.E. Sm., p. 240
Graphis alboglauescens Adaw. & Makhija, p. 312
Graphis eburnea Adaw. & Makhija, p. 314
Graphis filiformis Adaw. & Makhija, p. 314
Graphis meghalayaensis Adaw. & Makhija, p. 317
Graphis salacinilongiramea Adaw. & Makhija, p. 318
Graphis subvittata Adaw. & Makhija, p. 322
Graphis valparaiensis Adaw. & Makhija, p. 323
Haploporus latisporus Juan Li & Y.C. Dai, p. 182
Helminthosporium constrictum Meng Zhang, T.Y. Zhang & W.P. Wu, p. 140
Helminthosporium multiseptatum Meng Zhang, T.Y. Zhang & W.P. Wu, p. 137
Helminthosporium subhyalinum Meng Zhang & T.Y. Zhang, p. 139
Heterodoassansia khandalensis (S.D. Patil & Gandhe) Vánky, p. 30
Heterodoassansia ranunculina (Davis) Vánky, p. 49
Hygroaster cleefii Franco-Molano & López-Quintero, p. 190
Hygrocybe virescens (Hesler & A.H. Sm.) Montoya & Bandala, p. 346
Hygrophorus penarioides Jacobsson & E. Larss., p. 341
Hymenoscyphus microserotinus (W.Y. Zhuang) W.Y. Zhuang, p. 128

- Lanzia aurantiaca* (W.Y. Zhuang) W.Y. Zhuang, p. 127
- Lecanora legalloana* Elix & Øvstedal, p. 94
- Macalpinomyces patilorum* Vánky & A.R. Patil, p. 47
- Mollicamarops* Lar. N. Vassiljeva, p. 160
- Mollicamarops stellata* Lar. N. Vassiljeva, p. 160
- Orbilina vermiformis* Baral, Z.F. Yu & K.Q. Zhang, p. 272
- Perenniporia rhizomorpha* B.K. Cui, Y.C. Dai & Decock, p. 176
- Psilocybe mescaleroensis* Guzmán, Walstad, E. Gándara & Ram.-Guill., p. 225
- Punctelia fimbriata* Marcelli & Canêz, p. 212
- Punctelia purpurascens* Marcelli & Canêz, p. 214
- Restiosporium guringaliae* Vánky & R.G. Shivas, p. 38
- Sporidesmium delavayae* Ch. K. Shi & X. G. Zhang, p. 359
- Sporidesmium ilicis* Jian Ma & X.G. Zhang, p. 369
- Sporidesmium ochrae* Ch. K. Shi & X. G. Zhang, p. 365
- Sporidesmium phoebes* Ch. K. Shi & X. G. Zhang, p. 362
- Sporidesmium pruni* Jian Ma & X.G. Zhang, p. 369
- Sporidesmium tarenniae* Ch. K. Shi & X. G. Zhang, p. 361
- Sporisorium chrysopogonis-fulvi* (A.R. Patil, T.M. Patil & M.S. Patil) Vánky & A.R. Patil, p. 50
- Sporisorium magnusianum* (A.A. Fisch. Waldh.) Vánky, p. 9
- Sporisorium muticae* Vánky & A.R. Patil, p. 47
- Sporisorium myanmarensense* Vánky & R.G. Shivas, p. 42
- Sporisorium paspali* (Speg.) Vánky, p. 2
- Sporisorium setariae-mombassanae* (L. Ling) Vánky, p. 11
- Sporisorium tembuti* (Henn. & Pole-Evans) Vánky, p. 63
- Sporopodium leprosum* Øvstedal & Elix, p. 95
- Tilletia beckeriae* (Henn.) Vánky, p. 51
- Tilletia melicae* Vánky, p. 35
- Tilletia setariae-parviflorae* Vánky & R.G. Shivas, p. 11
- Tilletia setariae-pumilae* Vánky & N.D. Sharma, p. 64
- Tilletia shivasii* Vánky, p. 36
- Tilletia sleumeri* (Petr.) Vánky, p. 52
- Tilletia sphaerocarpa* (Syd. & P. Syd.) Vánky, p. 51
- Tilletia thailandica* Vánky & R.G. Shivas, p. 19
- Urocystis pedicularis* (Golovin) Vánky, p. 48
- Ustilago glabra* (A.R. Patil, T.M. Patil & M.S. Patil) Vánky & A.R. Patil, p. 49
- Ustilago planetella* Vánky & R.G. Shivas, p. 24

AUTHOR INDEX—VOLUME 99

- Abbasi, Mehrdad, see Moradali & al.
- Adawadkar, Bharati & Urmila Makhija. New species and new records of *Graphis* from India with partially carbonized exciples and transseptate ascospores. 99: 303–326. 2007.
- Alli, Hakan, Mustafa Işıloğlu, & M. Halil Solak. Macrofungi of Aydın Province, Turkey. 99: 163–165. 2007.
- Bai, Xueliang, see Liu & al.
- Bandala, Victor, see Montoya & Bandala
- Bandala, Victor M., see Montoya & al.
- Baral, H.-O., see Yu & al.
- Bernicchia, Annarosa, Leif Ryvarden & Tatiana Baptista Gibertoni. *Antrodiella semistipitata* (Basidiomycetes, Polyporales), a new species from Italy. 99: 231–237. 2007.
- Bougher, Neale L.. The genus *Campanella* in Western Australia. 99: 327–335. 2007.
- Braun, Uwe, see Liu & al.
- Burgaz, Ana Rosa & José Raggio. The *Cladoniaceae* in the Navarino Island (Prov. Antártica Chilena, Chile). 99: 103–116. 2007.
- Candan, Mehmet, see Halıcı & al.
- Canêz, Luciana S. & Marcelo P. Marcelli. Two new species of *Punctelia* (Parmeliaceae) from southern Brazil. 99: 211–216. 2007.
- Castillo-Ayoui, Flora, see Guzmán & al.
- Cavalcanti, Maria A.Q., see Wartchow & al.
- Coronado, Martha, see Lizárraga & al.
- Cui, Bao-Kai, Yu-Cheng Dai & Cony Decock. A new species of *Perenniporia* (Basidiomycota, Aphyllophorales) from eastern China. 99: 175–180. 2007.
- Dai, Yu-Cheng, see Cui & al.
- Dai, Yu-Cheng, see Li & al.
- Decock, Cony, see Cui & al.
- Elix, John A., see Øvstedal & Elix
- Erdoğan, Makbule & Elşad Hüseyin. The world's second record of *Hyalodictyum colchicum* reported from Turkey. 99: 245–250. 2007.
- Esqueda, Martín, see Lizárraga & al.
- Franco-Molano, Ana Esperanza & Carlos Alberto López-Quintero. A new species of *Hygroaster* (Hygrophoraceae, Agaricales) from Colombia. 99: 189–195. 2007.
- Gándara, Etelvina, see Guzmán & al.
- Ghods, Shirin, see Moradali & al.
- Gibertoni, Tatiana Baptista, see Bernicchia & al.
- Gomes, Alexandra L., see Pires-Zottarelli & al.
- Grand, L.F. & C.S. Vernia. Biogeography and hosts of period wood decay fungi in North Carolina: species of *Abortiporus*, *Bondarzewia*, *Grifola*, *Heterobasidion*, *Laetiporus*, and *Meripilus*. 99: 99–102. 2007.

Guo, Lin, see He & Guo

Guo, Lin. *Anthracoidea setschwanensis* sp. nov. (*Ustilaginales*) and a new record of *Anthracoidea* from China. 99: 227–230. 2007.

Guzmán, Gastón, Flora Castillo-Ayoui, Etelvina Gándara & Transversin Vivero. First record of the genus *Phlebopus* (*Basidiomycotina*, *Boletales*) in Ecuador. 99: 217–221. 2007.

Guzmán, Gastón, Lee Walstad, Etelvina Gándara & Florencia Ramírez-Guillén. A new bluing species of *Psilocybe*, section *Stuntzii* from New Mexico, U.S.A. 99: 223–226. 2007.

Halıcı, Mehmet Gökhan, Ayşen Özdemir Türk & Mehmet Candan. New records of pyrenocarpous lichenicolous fungi from Turkey. 99: 201–206. 2007.

He, Shuanghui & Lin Guo. Two new records of *Entyloma* (*Entylomatales*) from China. 99: 197–200. 2007.

Hedjaroude, Ghorban Ali, see Moradali & al.

Hidayat, Iman, see Meeboon & al.

Hüseyin, Elşad, see Erdoğan & Hüseyin

İşıloğlu, Mustafa, see Allı & al.

Jacobsson, S. & E. Larsson. *Hygrophorus penarioides*, a new species identified using morphology and ITS sequence data. 99: 337–343. 2007.

Larsson, E., see Jacobsson & Larsson

Li, Juan, Yu-Cheng Dai & Hai-Sheng Yuan. A new species of *Haploporus* (*Basidiomycotina*) from China. 99: 181–187. 2007.

Liu, Chao-Yang, see Zhuang & Liu

Liu, Tiezhi, Xueliang Bai, Yingchun Wang & Uwe Braun. A new species and two new records of *Erysiphe* emend. from China. 99: 75–81. 2007.

Lizárraga, Marcos, Gabriel Moreno, Martín Esqueda, Alfonso Sánchez & Martha Coronado. Myxomycetes from Sonora, Mexico. 3: National Forest Reserve and Wildlife Refuge, Ajos-Bavispe. 99: 291–301. 2007.

López-Quintero, Carlos Alberto, see Franco-Molano & López-Quintero

Ma, Jian & Xiu-Guo Zhang. Taxonomic studies of *Sporidesmium* from China. 99: 367–371. 2007.

Ma, Jian & Xiu-Guo Zhang. Three new species of *Corynespora* from China. 99: 353–358. 2007.

Makhija, Urmila, see Adawadkar & Makhija

Manimohan, P., K. Agretious Thomas & V. S. Nisha. Agarics on elephant dung in Kerala State, India. 99: 147–157. 2007.

Marcelli, Marcelo P., see Canêz & Marcelli

Mata, Milagro, see Montoya & al.

Meeboon, Jamjan, Iman Hidayat, Chiharu Nakashima & Chaiwat To-anun. *Cercospora habenariicola* sp. nov. and some new records of cercosporoid fungi from Thailand. 99: 117–121. 2007.

Montoya, Leticia & Victor Bandala. *Hygrophorus virescens* is transferred to *Hygrocybe*. 99: 345–346. 2007.

- Montoya, Leticia, Victor M. Bandala & Milagro Mata. Studies on *Lactarius*: Two new records from Costa Rica and additional information from Mexico. 99: 279–290. 2007.
- Moradali, Mohammad Fata, Ghorban Ali Hedjaroude, Hossein Mostafavi, Mehrdad Abbasi, Shirin Ghods & Abbas Sharifi-Tehrani. The genus *Ganoderma* (*Basidiomycota*) in Iran. 99: 251–269. 2007.
- Moreno, Gabriel, see Lizárraga & al.
- Mostafavi, Hossein, see Moradali & al.
- Nakashima, Chiharu, see Meeboon & al.
- Nascimento, Cristiane De A., see Pires-Zottarelli & al.
- Nisha, V.S., see Manimohan & al.
- Øvstedal, Dag Olav, & John A. Elix. Three new lichen species from the French Antilles. 99: 91–97. 2007.
- Pires-Zottarelli, Carmen L., Alexandra L. Gomes & Cristiane De A. Nascimento. *Entophlyctis luteolus* in the Brazilian Atlantic Rainforest. 99: 207–210. 2007.
- Qiao, Min, see Yu & al.
- Raggio, José, see Burgaz & Raggio
- Ramírez-Guillén, Florencia, see Guzmán & al.
- Reeves, F. Brent, see Wangeline & Reeves
- Ryvarden, Leif, see Bernicchia & al.
- Sánchez, Alfonso, see Lizárraga & al.
- Sesli, Ertugrul. Preliminary checklist of the macromycetes of the East and Middle Black Sea Regions of Turkey. 99: 71–74. 2007.
- Sharifi-Tehrani, Abbas, see Moradali & al.
- Shi, Cheng-Kui & Xiu-Guo Zhang. Taxonomic studies of *Sporidesmium* from Guangxi, China. 99: 359–366. 2007.
- Smith, Matthew E. NATS truffle and truffle-like fungi 15: *Genea balsleyi* sp. nov. (*Pyrenomataceae*), a new hypogeous ascomycete from New Jersey. 99: 239–244. 2007.
- Solak, M. Halil, see Ali & al.
- Thomas, K. Agretious, see Manimohan & al.
- To-anun, Chaiwat, see Meeboon & al.
- Tulloss, Rodham E., see Wartchow & al.
- Türk, Ayşen Özdemir, see Halıcı & al.
- Vánky, Kálmán. Taxonomic studies on *Ustilaginomycetes* — 27. 99: 1–70. 2007.
- Vasilyeva, Larissa N. *Pyrenomycetes* of the Russian Far East 2. *Mollicamarops stellata* gen. et sp. nov. 99: 159–162. 2007.
- Vernia, C.S., see Grand & Vernia
- Vivero, Transversin, see Guzmán & al.
- Walstad, Lee, see Guzmán & al.
- Wang, Yingchun, see Liu & al.
- Wangeline, Ami L. & F. Brent Reeves. Two new *Alternaria* species from selenium-rich habitats in the Rocky Mountain Front Range. 99: 83–89. 2007.

- Wartchow, Felipe, Rodham E. Tulloss & Maria A.Q. Cavalcanti. The discovery of *Amanita liloi* in Brazil. 99: 167–174. 2007.
- Wu, Wen-Ping, see Zhang & al.
- Yu, Zefen, Min Qiao, Ying Zhang, H.-O. Baral, & Keqin Zhang. *Orbilia vermiformis* sp. nov. and its anamorph. 99: 271–278. 2007.
- Yuan, Hai-Sheng, see Li & al.
- Zhang, Guang-Min & Xiu-Guo Zhang. Two new species of *Corynespora* from Guangdong, China. 99: 347–351. 2007.
- Zhang, Keqin, see Yu & al.
- Zhang, Meng & Tian-Yu Zhang. Taxonomic studies of *Alternaria* from China X. Two new species on *Polygonum*. 99: 133–136. 2007.
- Zhang, Meng & Tian-Yu Zhang. Taxonomic studies of *Curvularia* from China III. Two new species on *Poaceae*. 99: 143–146. 2007.
- Zhang, Meng, Tian-Yu Zhang & Wen-Ping Wu. Taxonomic studies of *Helminthosporium* from China III. Three new species in Guangdong Province. 99: 137–142. 2007.
- Zhang, Tian-Yu, see Zhang & al.
- Zhang, Tian-Yu, see Zhang & Zhang
- Zhang, Xiu-Guo, see Ma & Zhang
- Zhang, Xiu-Guo, see Shi & Zhang
- Zhang, Xiu-Guo, see Zhang & Zhang
- Zhang, Ying, see Yu & al.
- Zhuang, Wen-Ying & Chao-Yang Liu. Taxonomic reassessment of two taxa of helotialean fungi. 99: 123–131. 2007.

REVIEWERS, VOLUME NINETY-NINE

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

Ahmet Afyon	David L. Hawksworth	Tuomo Niemela
Teuvo Ahti	Kevin D. Hyde	Lorelei L. Norvell
Tetiana V. Andrianova	W. Bryce Kendrick	Nichole O'Neill
Alan W. Archer	Henning Knudsen	Alan Orange
Richard Baird	Muhsin Konuk	Clark L. Ovrebo
Timothy J. Baroni	Richard P. Korf	Mary E. Palm
Dominik Begerow	Teresa Lebel	Shaun R. Pennycook
Dasha Belomesyatseva	Bruno Le Cam	Donald H. Pfister
Uwe Braun	Peter M. Letcher	Marcin Piątek
Peter Buchanan	Shidong Li	Rodney Roberts
Vagner G. Cortez	Xingzhong Liu	Gary J. Samuels
Kanad Das	D. Jean Lodge	Hyeon-Dong Shin
Cony Decock	Joyce L. Longcore	Roger G. Shivas
Robert Egan	Robert Lücking	Soili Stenroos
John A. Elix	Tom May	Steven L. Stephenson
Dean Glawe	Patrick M. McCarthy	James M. Trappe
Gro Gulden	Eric H.C. McKenzie	Petr Vampola
Ying-Lan Guo	Vadim A. Mel'nik	Kálmán Vánky
Laura Guzmán-Dávalos	Armin Mesic	Else C. Vellinga
Nils Hallenberg	David W. Mitchell	Zhu L. Yang
Lauraine Hawkins	Gregory M. Mueller	Wen-Ying Zhuang

ERRATA

VOLUME 91

Hygrocybe virescens, as cited on pp. 477 (line 1 and line one up from bottom) and 478 & 479 (legends, line 1), is invalid. See the current volume (*Mycotaxon* 99: 345-346. 2007) for valid publication of the combination.

VOLUME 98

p.159, line 13

for: Universidade Federal de Pernambuc

read: Universidade Federal de Pernambuco

p.311, line 2

for: see Gilberto

read: see Coelho

p312, line 21

delete: Lepiotaceous fungi in California, U.S.A. 3.

MYCOTAXON is published quarterly during the periods of January–March, April–June, July–September, and October–December by **MYCOTAXON, LTD.**, 316 Richard Pl., Ithaca, NY 14850–0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2007 & 2008: In U.S. and possessions, one year, \$330.00; reduced rate for personal subscribers, one year, \$150.00. All foreign subscriptions: Canada/Mexico add \$15, all other countries add \$40 for IMS air mail.

POSTMASTER!

Send address changes to **MYCOTAXON, LTD.**

P.O. Box 264, Ithaca, NY 14851-0264 USA

THE '4-STEP' MYCOTAXON SUBMISSION PROCESS

MYCOTAXON's instructions PDF (updated in 2006), which can be downloaded from the INSTRUCTIONS TO AUTHORS webpage on www.mycotaxon.com, provides more information than the abbreviated version last published in MYCOTAXON (94: 401–411). As we continue to simplify submission protocols, we urge prospective authors to download other guides by clicking the 'file download page' link on the instructions page and to read the Editor's blog [www.mycotaxon.com/about/weblog.html] for last minute changes before submitting to the journal.

Step 1—PEER REVIEW: Authors send a formatted text document with illustration files and MYCOTAXON Reviewer checklist to two experts for peer review. Authors should (i) make certain that both peer reviewers have Emailed the checklist forms to the *Editor-in-Chief* and (ii) revise their manuscript according to reviewer suggestions **before** submitting a master text file to the *Nomenclature Editor* for nomenclatural review.

Step 2—NOMENCLATRURAL & FRENCH LANGUAGE REVIEW: Authors next Email their revised master text file (containing footnotes, tables and captions but *NO* illustrations) to the *Nomenclature Editor* <PennycookS@LandcareResearch.co.nz> for accession and pre-submission review. The Email message *MUST* include the word 'MYCOTAXON' on the subject line and *MUST* include names **and** Email addresses of all peer reviewers. (Manuscripts written in French should also be submitted to the *French Language Editor* <decock@mbia.ucl.ac.be> at this time.) Editors will return annotated files with a list of needed corrections to the authors and *Editor-in-Chief*.

Step 3—FINAL SUBMISSION: After authors receive their manuscript accession number and make revisions requested during nomenclatural review, they should send (i) a completed MYCOTAXON submission form; (ii) separate text files for main text, tables, and legends; and (iii) art files to the *Editor-in-Chief* <editor@mycotaxon.com>. **Only** text and image files considered ready for immediate publication should be sent at this time. The *Editor-in-Chief* will try to acknowledge receipt of files within two weeks. Authors are asked to wait at least 14 days before sending a follow-up query, to avoid unnecessary Email traffic near press deadlines or during temporary closures of the editorial office.

Step 4—PRESS PREPARATION: After preparing a press-quality PDF from the author's text and art files, the *Editor-in-Chief* sends journal entries for the nomenclatural novelties and author index pages with the PDF proof to all coauthors for approval. Editorial errors are always corrected free of charge, but authors who ask the *Editor-in-Chief* to correct errors present in their original files will be charged \$10 per correction (minimum charge of \$40). Payment arrangements of all fees should be made by writing the *Treasurer* <info@mycotaxon.com>.

MYCOTAXON frequently updates its webpages and regularly posts abstracts, table of contents, indices, distributional checklists, and revised instructions and forms on its website. We invite all of you to browse our website frequently for updated journal and other interesting mycological news.

RECENT BOOKS FROM MYCOTAXON

Prices include surface mail shipment (*for more books, see www.mycotaxon.com/books.html*)
Mycotaxon, Ltd., P. O. Box 264, Ithaca, NY 14851-0264, U.S.A.

Fungi of China, by S. C. Teng

Mycotaxon, Ltd. 1996. Hardbound, xiv + 586 pp., 426 illustrations, map, portrait, index, 8–1/2x11 in. \$79.00.

Airmail price varies by country: enquire. ISBN 0-930845-05-6.

Edited by Richard P. Korf, with a foreword by Teng's daughter, Rosaline Z. Deng.

Proceeds from sales go to the Teng family.

Special for *Mycotaxon* subscribers: deduct \$20 from regular price!

What reviewers say about Teng's Fungi of China:

"... one of the most valuable books on the fungi of China ever published in English." —*Mycologia* 90: 1091-1092, 1998.

"... a great big blue uncompromising brick of a book ... an instant classic. Anyone interested in identification of fungi, particularly in Asia, should get this book immediately. Mycology owes another debt to Dick Korf for his sympathetic and intelligent editing of this superb work." —*Bibliography of Systematic Mycology* 10(6): xlviii-xlix. 1998.

"The book is important for any researcher interested in the systematic relationships, diversity, and distribution of fungi on a global scale." — *New Zealand Journal of Botany* 35: 265-266. 1977.

Central European Lichens - Diversity and Threat,

edited by Anna Lackovicova, Anna Guttova, Eva Lisicka & Pavel Lizon

Mycotaxon, Ltd. 2006. Hardbound and Softbound editions, 364 pp., illustrated, 17 x 24 cm.

For exchange only, contact Eva Zaletova, Institute of Botany, Slovak Academy of Sciences,

Dubravska cesta 14, 845 23 Bratislava, Slovakia, <eva.zaletova@savba.sk>.

ISBN 0-930845-14-5 (hardbound ed.), 0-930845-15-3 (softbound ed.)

This is a *Festschrift* dedicated to Ivan Pisut. Contributing authors: Martin Backor, Viera Banasova, Franc Batic, Urszula Bielczyk, Peter O. Bilovitz, Stanislaw Cieslinski, Krystyna Czerwaska, Radek Detinsky, Adam Flakus, Joanna Galas, Anna Guttova, Josef P. Halda, Hannes Hertel, Ludwik Lipnicki, Jozef Liszka, Jana Kocourkova, Robert Koscielniak, Beata Krzewicka, Anna Lackovicova, Eva Lisicka, Jiri Liska, Karol Marhold, Helmut Mayrhofer, Rok Mesl, Walter Obermayer, Zdenek Palice, Tina Randlane, Andres Saag, Stepanka Slavikova-Bayerova, Viera Slezakova, Lucyna Sliwa, Roman Turk, Jan Vondrak.

Fungi of Northwestern China, edited by Wen-Ying Zhuang

Mycotaxon, Ltd. 2005. Hardbound, 430 pp., 26 x 18.5 cm. US\$40.00 plus postage. ISBN 0-930845-14-5.

(Please order direct from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 3887 named species belonging to 759 genera of fungi (slime molds, plasmodiophoromycetes, chytrid, oomycetes, zygomycetes, lichens, non-lichenized ascomycetes, anamorphic fungi, rusts, smuts, and the basidiomycetous macrofungi) hitherto known from Gansu, Ningxia, Qinghai, Shaanxi and Xinjiang, China are listed. Useful references, detailed tropical distribution, and hosts or substrates are provided for each species. *Contributing authors:* Shuang-Lin Chen, Lin Guo, Shou-Yu Guo, Ying-Lan Guo, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Xiao-Qing Zhang, Jian-Yun Zhuang, and Wen-Ying Zhuang.

Higher Fungi of Tropical China, edited by Wen-Ying Zhuang

Mycotaxon, Ltd. 2001. Cloth bound, 485 pp., 26 x 18.5 cm. US\$50.00 plus postage. ISBN 0-930845-13-7.

(Please order direct from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 5056 named species belonging to 1192 genera of higher fungi hitherto known from tropical China are listed.

Useful references, detailed tropical distribution, and hosts or substrates are provided for each species.

Contributing authors: Lin Gou, Shou-Yu Guo, Ying-Lan Guo, Xiao-Lan Mao, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Zhi-He Yu, Xiao-Qing Zhang, Jian-Yun Zhuang, and Wen-Ying Zhuang.

Mycotaxon Cumulative Index for Volumes XLI-LX (1991-1996)

Karen D. Gettelman, Richard P. Korf, Susan C. Gruff & Ian F. Korf

Mycotaxon, Ltd. 1998. Softbound, 296 pp., 6x9 inches. \$35.00. Airmail, \$55.00. ISBN 0-930845-07-2.

Mycotaxon Cumulative Index for Volumes XXI-XL (1984-1991)

Richard P. Korf & Susan C. Gruff

Mycotaxon, Ltd. 1991. Softbound, 352 pp., 6x9 inches. \$30.00. Airmail, \$50.00. ISBN 0-930845-01-3.

Mycotaxon Cumulative Index for Volumes I-XX (1974-1984)

Richard P. Korf & Susan C. Gruff

Mycotaxon, Ltd. 1984. Softbound, 232 pp., 6x9 inches. \$17.50. Airmail, \$37.50.

ISBN 0-930845-00-5.

Myxomycetes from Sonora, Mexico. 3: National Forest Reserve and Wildlife Refuge, Ajos-Bavispe	Marcos Lizárraga, Gabriel Moreno, Martín Esqueda, Alfonso Sánchez & Martha Coronado	291
New species and new records of <i>Graphis</i> from India with partially carbonized exciples and transseptate ascospores	Bharati Adawadkar & Urmila Makhija	303
The genus <i>Campanella</i> in Western Australia	Neale L. Bougher	327
<i>Hygrophorus penarioides</i> , a new species identified using morphology and ITS sequence data	S. Jacobsson & E. Larsson	337
<i>Hygrophorus virescens</i> is transferred to <i>Hygrocybe</i>	Leticia Montoya & Victor Bandala	345
Two new species of <i>Corynespora</i> from Guangdong, China	Guang-Min Zhang & Xiu-Guo Zhang	347
Three new species of <i>Corynespora</i> from China	Jian Ma & Xiu-Guo Zhang	353
Taxonomic studies of <i>Sporidesmium</i> from Guangxi, China	Cheng-Kui Shi & Xiu-Guo Zhang	359
Taxonomic studies of <i>Sporidesmium</i> from China	Jian Ma & Xiu-Guo Zhang	367
Indices & Information		
<i>Nomenclatural novelties proposed in volume 99</i>		373
<i>Author index</i>		375
<i>Reviewers</i>		379
<i>Errata</i>		380
<i>Submission to MYCOTAXON</i>		381

EDITORS OF MYCOTAXON

Lorelei L. Norvell, EDITOR-IN-CHIEF
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard
Portland, OR 97229, U.S.A

Shaun R. Pennycook, NOMENCLATURE EDITOR
PennycookS@LandcareResearch.co.nz
Manaaki Whenua Landcare Research
Auckland, New Zealand

David L. Hawksworth
BOOK REVIEW EDITOR
MycNova, Calle Aguila 12
Colonia La Maliciosa, Mataelpino
ES-28411 Madrid, Spain

Karen D. Gettelman
INDEX EDITOR
510 Lake Blvd., Apt. 166
Davis, CA 95616
U.S.A.

Cony Decock
FRENCH LANGUAGE EDITOR
Place Croix du Sud 3
B-1340 Louvain-la-Neuve
Belgium

MYCOTAXON is a quarterly, peer-reviewed journal devoted to mycological taxonomy and nomenclature. All articles are reviewed by specialists prior to submission. Publication is open to everyone. Papers may be in English or in French. Summaries in those or any additional languages desired by the authors are given for longer articles. Printing is on high quality, acid-free book paper. Authors prepare their own *text-ready* files after having received critical comments from pre-submission reviewers and nomenclatural review by the Nomenclature Editor. *Instructions to Authors* (Mycotaxon 94: 401–411, 2005) and *Guidelines for Reviewers* are updated and can be downloaded from our website at <www.mycotaxon.com>.

SUBSCRIPTION INFORMATION

All subscriptions are on an annual basis, with four quarterly volumes each year. Personal subscriptions are available at a substantially reduced rate for those who agree not to deposit their copies in a library other than their personal one within 3 years of receipt. Address all orders to the MYCOTAXON ORDER DEPARTMENT, P.O. Box 264, Ithaca, NY 14851-0264 USA, or your agent. Prices and availability of back volumes are posted online at <www.mycotaxon.com> or can be provided on request by Email from <info@mycotaxon.com>. Mycotaxon may be obtained on a journal-exchange basis. Proposals for such exchanges from journals, institutions, or individuals with difficulty in obtaining foreign currency should be addressed to the Order Department.

The annual subscription rates for 2007 (four volumes annually) are

	USA	Canada/Mexico (air assist)	Foreign (air assist)
REGULAR (multi-user)	\$330	\$345	\$370
PERSONAL (individual)	\$150	\$165	\$190

All back volumes [except volumes 22, 24, 34, 35, 41, 54, and 64, currently out of print] are available at \$35 each by surface mail, \$55 each by air mail. Volumes 1, 38, 39, 43 and 46 were reprinted in 2001; the original printing of volume 1, part 1 is provided, with parts 2 and 3 reprinted.

CUMULATIVE INDICES

Printed versions of the *Mycotaxon Cumulative Indices* for Volumes 1–20 (ISBN 0-930845-00-5), Volumes 21–40 (ISBN 0-930845-01-03), and Volumes 41–60 (ISBN 0-930845-07-02) are available (see descriptions at <www.mycotaxon.com> and order there or through your local bookstore's listings under "Books in Print"). An online *Cumulative Index to Taxa in Volumes 61–ff.* and the *Cumulative Author Index to Volumes 61–ff.* are posted at <www.mycotaxon.com>.

AVAILABILITY IN MICROFILM, PHOTOCOPY, & ELECTRONIC VERSIONS

MYCOTAXON is also partially available in *microfilm* from National Archive Publishing Company <www.napubco.com>. *Tear sheets* or *photocopies* of individual articles may be obtained from ISI Document Solution <www.isidoc.com>. Many back volumes are available as free downloads through Cyberliber <www.cybertruffle.org.uk/cyberliber/index.htm> under 'Catalogues & Journals'.

CONTACTING MYCOTAXON'S EDITOR-IN-CHIEF BY E-MAIL OR FAX

To reach the Editor-in-Chief regarding manuscripts, E-mail to <editor@mycotaxon.com> or Fax to Lorelei L. Norvell at +503.297.3296.

CONTACTING MYCOTAXON'S ORDER DEPARTMENT BY E-MAIL OR FAX

To reach the Order Department for information or placing orders, you may E-mail to <info@mycotaxon.com> or you may Fax to Orders, Mycotaxon, Ltd., May–October at +607.273.4357, and November–April at +727.321.1460.

VISIT MYCOTAXON ON THE WORLD WIDE WEB AT <www.mycotaxon.com>

K
00
92
00
07

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

VOLUME 100

DEDICATED TO GRÉGOIRE L. HENNEBERT

APRIL-JUNE 2007

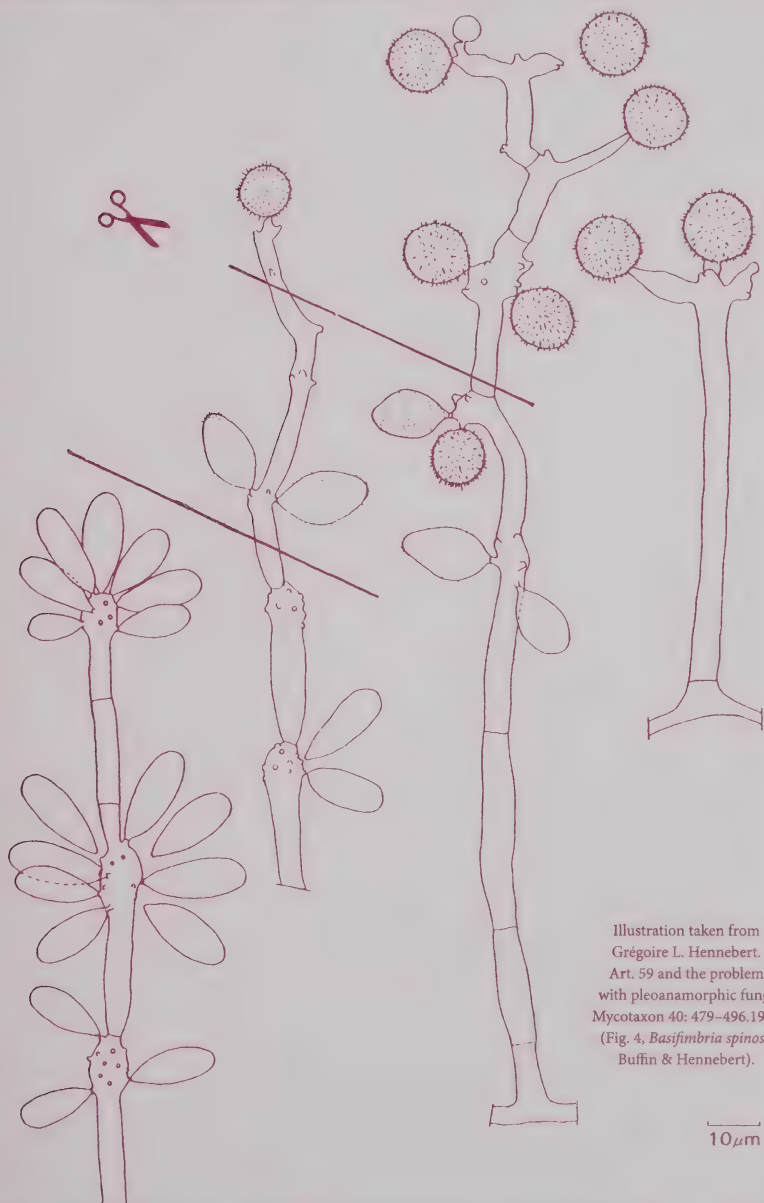


Illustration taken from
Grégoire L. Hennebert.
Art. 59 and the problem
with pleoanamorphic fungi
Mycotaxon 40: 479-496.1991
(Fig. 4, *Basifimbria spinosa*
Buffin & Hennebert).

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

MYCOTAXON is a quarterly, peer-reviewed journal devoted to mycological taxonomy and nomenclature. All articles are reviewed by specialists prior to submission. Publication is open to everyone. Papers may be in English or in French. Summaries in those or any additional languages desired by the authors are given for longer articles. Printing is on high quality, acid-free book paper. Authors prepare their own *text-ready* files after having received critical comments from pre-submission reviewers and nomenclatural review by the Nomenclature Editor. *Instructions to Authors* (Mycotaxon **94**: 401–411, 2005) and *Guidelines for Reviewers* are updated and can be downloaded from our website at <www.mycotaxon.com/authors/downloads.html>. Submission procedures are presented in the last pages of each volume.

SUBSCRIPTION INFORMATION

All subscriptions are on an annual basis, with four quarterly volumes each year. Personal subscriptions are available at a substantially reduced rate for those who agree not to deposit their copies in a library other than their personal one within 3 years of receipt. Address all orders to the MYCOTAXON ORDER DEPARTMENT, P.O. Box 264, Ithaca, NY 14851-0264 USA, or your agent. Prices and availability of back volumes are posted on-line at <www.mycotaxon.com> or can be provided on request by Email from <info@mycotaxon.com>. Mycotaxon may be obtained on a journal-exchange basis. Proposals for such exchanges from journals, institutions, or individuals with difficulty in obtaining foreign currency should be addressed to <info@mycotaxon.com>.

The annual subscription rates for 2007 (four volumes annually) are

	USA	Canada/Mexico (air assist)	Foreign (air assist)
REGULAR (multi-user)	\$330	\$345	\$370
PERSONAL (individual)	\$150	\$165	\$190

All back volumes [except volumes 22, 24, 34, 35, 41, 54, and 64, currently out of print] are available at \$35 each by surface mail, \$55 each by air mail. Volumes 1, 38, 39, 43 and 46 were reprinted in 2001; the original printing of volume 1, part 1 is provided, with parts 2 and 3 reprinted.

CUMULATIVE INDICES

Printed versions of the *Mycotaxon Cumulative Indices* for Volumes 1–20 (ISBN 0-930845-00-5), Volumes 21–40 (ISBN 0-930845-01-03), and Volumes 41–60 (ISBN 0-930845-07-02) are available (see descriptions at <www.mycotaxon.com> and order there or through your local bookstore's listings under "Books in Print"). An online *Cumulative Index to Taxa in Volumes 61–ff.* and the *Cumulative Author Index to Volumes 61–ff.* are posted at <www.mycotaxon.com>.

AVAILABILITY IN ELECTRONIC VERSIONS

Many back volumes are available as downloads through Cyberliber <www.cybertruffle.org.uk/cyberliber/index.htm> under 'Journals'.

CONTACTING MYCOTAXON'S EDITOR-IN-CHIEF BY E-MAIL OR FAX

To reach the Editor-in-Chief regarding manuscripts, E-mail to <editor@mycotaxon.com> or Fax to Lorelei L. Norvell at +1.503.297.3296.

CONTACTING MYCOTAXON'S ORDER DEPARTMENT BY E-MAIL OR FAX

To reach the Order Department for information or placing orders, you may
E-mail to <subscriptions@mycotaxon.com> or
Fax to Orders, Mycotaxon, Ltd. at +1.607.273.4357.

VISIT MYCOTAXON ON THE WORLD WIDE WEB AT <www.mycotaxon.com>

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

VOLUME 100

APRIL-JUNE, 2007

EDITOR-IN-CHIEF

LORELEI L. NORVELL

editor@mycotaxon.com

Pacific Northwest Mycology Service

6720 NW Skyline Boulevard

Portland, Oregon 97229-1309 USA

A.R. MANN LIBRARY

JUN 5 2007

ITHACA, NY 14853

ASSOCIATE EDITORS

NOMENCLATURE EDITOR

SHAUN R. PENNYCOOK

PennycookS@LandcareResearch.co.nz

Manaaki Whenua Landcare Research

Auckland, New Zealand

BOOK REVIEW EDITOR

DAVID L. HAWKSWORTH

MycoNova, Calle Aguila 12

Colonia La Maliciosa, Mataelpino

ES-28411 Madrid, Spain

FRENCH LANGUAGE EDITOR

CONY DECOCK

Place Croix du Sud 3

B-1340 Louvain-la-Neuve, Belgium

INDEX EDITOR

KAREN D. GETTELMAN

2748 Ottawa Ave.

Davis, CA 90046 U.S.A.

CONSISTING OF VI + 370 PAGES INCLUDING FIGURES

EDITORIAL ADVISORY BOARD

WEN-YING ZHUANG (2003-2008), Chair
Beijing, China

DONALD H. PFISTER (1997-2007), Past Chair
Cambridge, Massachusetts, USA

CAROL A. SHEARER (1998-2009)
Urbana, Illinois, USA

SHAUN ROSS PENNYCOOK (2005-2010)
Auckland, New Zealand

SEPPÖ HUHTINEN (2006-2011)
Turku, Finland

GARY J. SAMUELS (1997-2012)
Beltsville, Maryland, USA

Published by
MYCOTAXON, LTD, P. O. BOX 264
Ithaca, NY 14851-0264, USA

WWW.MYCOTAXON.COM
Printed in the United States of America
© Mycotaxon, Ltd, 2007

MYCOTAXON

VOLUME ONE HUNDRED — TABLE OF CONTENTS

A tribute to Grégoire Laurent Hennebert and Mycotaxon's 100th volume	Richard P. Korf	1
South American polypores: first annotated checklist from		
Argentinean Yungas	Gerardo L. Robledo & Mario Rajchenberg	5
Phylogenetic relationships and nomenclature of <i>Bremiella sphaerosperma</i>		
(<i>Chromista</i> , <i>Peronosporales</i>)	Hermann Voglmayr & Marco Thines	11
Five lichens new to Turkey	Kenan Yazıcı & André Aptroot	21
Typification and description of <i>Typhula buxi</i>	I. Olariaga, M.P. Hoyo, A. Gómez-Bolea & I. Salcedo	27
<i>Cyathicula brunneospora</i> and <i>Pirottaea atrofusca</i> , two new <i>Helotiales</i>		
from Tian Shan (Kazakhstan)	Markéta Chlebická & Andrzej Chlebicki	37
<i>Amaurodon sumatranus</i> (<i>Thelephorales</i> , <i>Basidiomycota</i>), a new species		
from Indonesia	Otto Miettinen & Urmas Köljal	51
Four new Chinese records of <i>Petriella</i> and <i>Pseudallescheria</i> (<i>Microascales</i>)		
	Guangyu Sun, Junlin Zhang & Rong Zhang	61
New records of smut fungi from Korea. 1	Cvetomir M. Denchev,	
	Young-Joon Choi, Seung-Kyu Lee & Hyeon-Dong Shin	67
New records of smut fungi from Korea. 2	Cvetomir M. Denchev,	
	Hyeon-Dong Shin & Sung Min Kim	73
A new record of <i>Bauhinus piperi</i> (<i>Microbotryales</i>) from Pakistan		
	Muhammad Asim Sultan, Cvetomir M. Denchev, Ikram-ul-Haq & A.N. Khalid	79
Rhizomorph anatomy confirms the taxonomic position of <i>Sclerogaster</i>		
(<i>Phallomycetidae</i> , <i>Basidiomycota</i>)	H. Cléménçon, K. Hosaka & A.F.S. Taylor	85
Notes on <i>Amphisphaeria</i> -like species in HMAS, with a new combination:		
<i>Phaeodothis hainanensis</i> (<i>Pleosporales</i>)	You-Zhi Wang & Wen-Hua He	97
<i>Mycoblastus marginatus</i> , a new synonym for <i>M. affinis</i> (<i>Mycoblastaceae</i> ,		
lichenized <i>Ascomycota</i>)	Toby Spribille & Tor Tønsberg	105
Fruitbodies of <i>Cenococcum geophilum</i>	L.M. Fernández-Toirán & B. Águeda	109
Coprophilous ascomycetes of Thailand	Onuma Jeamjitt, Leka Manoch,	
	Niphon Visarathanonth, Chiradej Chamswarn,	
	Roy Watling, George P. Sharples & Anake Kijjoa	115
<i>Colletotrichum yunnanense</i> sp. nov., a new endophytic species		
from <i>Buxus</i> sp.	Xiaoying Liu, Xiangming Xie & Junxing Duan	137
Additions to the lichen mycota of Iran from East Azerbaijan Province		
	Mohammad Sohrabi & Vagn Alstrup	145
Taxonomic studies of <i>Pseudospiropes</i> from Yunnan, China		
	Zhi-Qiang Shang & Xiu-Guo Zhang	149
Two new <i>Corynespora</i> species from Jiangsu, China		
	Zhi-Qiang Shang & Xiu-Guo Zhang	155
Two new <i>Alternaria</i> species from pear fruit	Rodney G. Roberts	159

- A new and noteworthy species of *Hygrophorus* from Yunnan, China
Fu-Qiang Yu, Guang-Bo Xu & Pei-Gui Liu 169
- New morphological data on *Amauroderma brasiliense* (Polyporales,
Basidiomycota) Gilberto Coelho, Vagner G. Cortez & Rosa T. Guerrero 177
- Aphyllphoraceous wood-inhabiting fungi on *Abies alba* in Italy
Annarosa Bernicchia, Elena Savino & Sergio Pérez Gorjón 185
- A new species of *Phaeoramularia* on *Ranunculaceae*
Feng-Yan Zhai, Ying-Lan Guo & Yu Li 189
- Two new species of *Agaricus* from the Subantarctic
József Geml, Gary A. Laursen, Harris C. Nusbaum & D. Lee Taylor 193
- Re-examinations of *Botryosphaeriaceae* (*Dothideomycetes*) from China
on deposit in HMAS Wen-Ying Li & Wen-Ying Zhuang 209
- Did Mussat make new combinations in Sylloge Fungorum XV, 1901?
H.-J. Schroers, G.J. Samuels & W. Gams 221
- A new species of *Conidiobolus* from Great Smoky Mountains
National Park Bo Huang, Richard A. Humber & Kathie T. Hodge 227
- Typification of *Umbilicaria cinereorufescens* Geir Hestmark 235
- Clitopilus amygdaliformis*, a new species from tropical China Zhu L. Yang 241
- First record of the genus *Byssosphaeria* (*Pleosporales*) in Mexico and
Venezuela Rosario Medel 247
- Phyllachora tengchongensis* sp. nov. and a new record of *Phyllachora* (*Phyllachorales*)
from China Na Liu & Lin Guo 251
- New records of lichenicolous and lichenized fungi from Turkey
Mehmet Gökhan Halıcı, Mehmet Candan & Ayşen Özdemir Türk 255
- Ripartitella* (*Agaricales*) from an Atlantic Forest in Pernambuco, Brazil
Felipe Wartchow, Jair Putzke & Maria A. Q. Cavalcanti 261
- Two rare corticioid species with globose spores
María Natividad Blanco, G. Moreno & J. Checa 269
- Type studies on *Chamaeota* species described from China Zhu L. Yang 279
- Mayamontana coccolobae* (*Basidiomycota*), a new sequestrate taxon
Michael A. Castellano, James M. Trappe & D. Jean Lodge 289
- Vittalia indica* gen. & sp. nov. and *Helicoma indicum* sp. nov. from the
forests of northeastern India Puja Gawas & D.J. Bhat 295
- Anomoloma*, a new genus separated from *Anomoporia* on the basis of
decay type and nuclear rDNA sequence data Tuomo Niemelä,
Karl-Henrik Larsson, Yu-Cheng Dai & Ellen Larsson 305
- New data and localities for *Navisporus* in America
Mabel Gisela Torres-Torres, Laura Guzmán-Dávalos & Leif Ryvarden 319
- Anamorphic fungi from submerged plant material: *Phaeomonilia*
pleiomorpha, *P. corticola* and *Cacumisporium pleuroconidiophorum*
Rafael F. Castañeda Ruiz, Gabriela Heredia Abarca, Rosa Maria Arias,
Masatoshi Saikawa, David Minter & Marc Stadler 327

Endococcus variabilis, a new species on *Staurothele areolata*

Mehmet Gökhan Halıcı, Jana Kocourkova,
Paul Diederich & Ahmet Aksoy 337

Fibricium gloeocystidiatum (Polyporales, Basidiomycetes), new to Europe

Luigi Arras, Andrea Piga, Annarosa Bernicchia & Sergio Pérez Gorjón 343

Taxonomic revision of the myxomycetes from Cuba deposited in three
reference collections: National Fungus Collections (BPI-USA), British

Museum (BM-UK) and Kew (K-UK) M. Camino, G. Moreno & A. Castillo 349

Indices & Information

Nomenclatural novelties proposed in volume 100 357

Author index 359

Reviewers 363

Errata 364

From the EDITOR-IN-CHIEF: MYCOTAXON 100 365

Submission to MYCOTAXON 367

PUBLICATION DATE FOR VOLUME NINETY-NINE

MYCOTAXON *for* JANUARY–MARCH, VOLUME 99 (1–382 + I–VI)

was issued on April 21, 2007

MYCOTAXON

Volume 100, pp. 1–4

April–June 2007

A tribute to Grégoire Laurent Hennebert and Mycotaxon's 100th volume

RICHARD P. KORF

RPK1@cornell.edu

*Department of Plant Pathology, Cornell University
Ithaca, NY 14853, U.S.A.*

Abstract—This 100th volume of Mycotaxon celebrates Professor Grégoire Hennebert's 32 years' involvement as a founding Co-Editor and French Language Editor. The evolution of the journal and the changes in journal technology over the years are briefly discussed, and thoughts on the future of the publication of taxonomic journals are advanced.

Key words—hard copy, online publication, registration of names, International Code of Botanical Nomenclature

The founding and evolution of Mycotaxon

The Editor-in-Chief has requested this brief history and to join with her in dedicating this 100th volume to founding Co-Editor Grégoire Hennebert for his many appreciated contributions to the journal, including 32 years as French Language Editor and 17 years as Book Review Editor. She asked me to provide the photograph (Fig. 1) showing Grégoire and me in 1973 in his laboratory at the Université Catholique de Louvain where I was on sabbatical leave, during which time we made many of our final journal decisions.

In the early 1970's Grégoire and I seriously began considering whether to start a new journal devoted solely to papers on taxonomy and nomenclature of fungi (including lichens). We were convinced that the need for rapid publication was not being met by other journals: one of our joint papers was held up for 14 months after submission. We concluded that part of the solution lay in reducing the time needed for the proofreading and correction of proofs. We designed Mycotaxon (Hennebert & Korf, 1974) to address those problems by taking advantage of publication by photo-offset lithography (as opposed to type-setting that all but a few journals were using), and by having authors send camera-ready copy with any and all errors the authors' fault, not the editors'. A second problem, the time involved in journal editors selecting and contacting reviewers, the sending back and forth of reviewers' comments, etc., we solved

in an unusual way: papers were to be reviewed *prior* to submission, and the authors were to select appropriate reviewers (Korf, 1974). Our reasoning was that authors would know—far better than we (as co-editors)—who those experts were in their area of taxonomy. We also disliked the whole concept of anonymous reviewers. Throughout my 60-year career I refused to supply any journal with an unsigned review, convinced that authors have a right to know who it is that criticizes their work. We were warned that authors would choose “easy” reviewers, but the facts are different. Authors regularly chose the very best in the field to act as their reviewers; some wrote us enthusiastic letters to thank us for this process, since they would not have dared to approach such eminent people had we not required it, and some then reported to us that years of close collaboration with these experts ensued.

When we began the journal, the typewriter was still the major tool for authors. By that time the development of the IBM Selectric® typewriter with changeable font “golf” balls allowed authors to prepare quite attractive manuscripts using a variety of typefaces including italic typestyles instead of underlining for Latin names. And, of course, the development of computer technology some years later resulted in far more easily produced author-prepared papers. Throughout my editorship (1974–1991, volumes 1–40) and those of Jean Boise Cargill (1991–1998, volumes 41–67), and Pavel Lizon (1998–2003, volumes 68–88), authors continued to submit camera-ready copy. Papers continued to vary from each other greatly in formatting, choices of typeface, literature citation, etc., though consistent within each paper. Our current Editor-in-Chief, Lorelei L. Norvell (2004–ff, volumes 89–ff), prompted by suggestions from our Editorial Advisory Board, opted for consistency in format and typefaces throughout, and eventually implemented submission of manuscripts electronically only. This is fully consistent with the changes throughout the publication industry: typesetting is no longer the rule for books or journals—these are now nearly all produced by photo-offset lithography and on computers. There is no doubt that the result renders a far more professional appearance. Changing to this new technology has resulted in a temporary loss of our goal of expediting publication, but we are confident we will again be able to make that claim by 2008.

Some thoughts on the future of taxonomic publication

Libraries face ever-increasing costs for journals, fuelled by developments in journals being taken over by profit-based publication firms that also price and package journals out of the reach of individuals. The development of online versions of print journals has completely changed the use of many university libraries, where students now rarely inhabit the stacks, but sit at computers and read their current journal articles online. For a field like ours, taxonomy, we



Fig. 1. Professors Grégoire L. Hennebert and Richard P. Korf at their workbench at the Université Catholique de Louvain in Heverlee, Belgium in 1973. The line drawings they are discussing are those of an anamorphic fungus, drawn by Professor Hennebert.

need libraries not only for the last few years' work, but need to access hundreds of years of literature that exists only in hard copy in libraries. A small but truly

important dent in this backlog of book and journal literature is now available to mycologists through a greatly appreciated source, Cyberliber, subtitled "an electronic library for mycology," at <www.cybertruffle.org.uk/cyberliber/index.htm>, which is in the process of making all back volumes of *Mycotaxon* and many other journals and valuable reference books available online.

That next technological innovation, the internet, brought still more important changes and challenges. What is the future of online journals, or more precisely, online journals that deal with taxonomy? The current International Code of Botanical Nomenclature (ICBN) does not accept online or CD publication of new names and combinations as valid. At least a few printed copies must be provided to libraries to meet its requirements. To validate publication of a major taxonomic book on fungi available only on CDs the workers at CABI printed out a few copies for library deposit to circumvent the ICBN restriction. Some new online-only journals also resort to printing out a few copies and depositing them to meet those perhaps archaic rules. A recent paper making the case for online publication of new biological names (Knapp & al. 2007) is worth consulting. Surely the next International Botanical Congress, where changes in the ICBN are approved, must act on this matter, and must attempt to resolve the ongoing debate on registration of the names of new taxa and combinations.

More to my point is: can journals like *Mycotaxon* survive as print-only? Economics comes sharply into play. These days many journals, particularly those printed abroad, can offer color illustrations at low or no cost. *Mycotaxon* cannot compete when it costs \$475 to produce a color plate, which we have to pass on to the authors. Look instead at online-only journals: they can provide authors an almost limitless number of beautiful color images at no cost. Some journals with both hard copy and online versions now print the hard copies with black and white halftones but allow the online versions to be in color. My belief is that the availability of free color images in online journals will dictate the choice of journal submissions for future generations of taxonomists. Our journal has a distinguished Editorial Advisory Board. We shall look to them to see whether *Mycotaxon* can evolve further and survive in this new world of publication.

The first hundred volumes has been a grand voyage. *Merci beaucoup, mon cher ami, Grégoire!*

Literature cited

- Hennebert GL, Korf RP. 1974. *Mycotaxon*, a new international journal on taxonomy and nomenclature of fungi and lichens. *Mycotaxon* 1: 1–2.
- Knapp S, Polaszek A, Watson M. 2007. Spreading the word. *Nature* 446(15): 261–262.
- Korf RP. 1974. Instructions to authors for preparing camera-ready manuscripts for *Mycotaxon*. *Mycotaxon* 1: 3–12.

South American polypores: first annotated checklist from Argentinean Yungas

GERARDO L. ROBLEDO¹ & MARIO RAJCHENBERG²

¹gerardorobledo@ecosistemasarg.org.ar

Instituto Multidisciplinario de Biología Vegetal – CONICET

Universidad Nacional de Córdoba, C.C. 495, 5000 Córdoba, Córdoba, Argentina

²mrajchenberg@ciefap.org.ar

Centro Forestal CIEFAP

C.C. 14, 9200 Esquel, Chubut, Argentina

Abstract — A preliminary checklist of the polypore mycota of “Yungas”, subtropical mountain forests of northwestern Argentina, is presented. An intensive search of records in literature was done, and polypore exsiccatae from that phytogeographic province kept at the main Argentinean herbaria were studied. A total of 850 specimens were revised and 111 species were determined. *Phellinus laevigatus* and *Skeletocutis stellae* are recorded for the first time in South America; 8 species are new records for Argentina and 31 new records for the region. The new combination *Dichomitus hexagonoides* is proposed. The complete checklist is available on:

<http://www.mycotaxon.com/resources/weblists.html>.

Key words — fungal diversity, wood decay fungi, neotropical montane forests

Introduction

Yungas ecosystem

A system of tropical and subtropical cloud montane forests is developed on the oriental slope along the Andes in South America. This system, called Andean Yungas Forests, is mainly defined by its occurrence on the slopes in an altitudinal range where the weather is characterized by a persistent or seasonal fog and cloud cover (Brown et al. 2005).

Andean Yungas Forests have their southern limit in NW Argentina where they are called Yungas and also known as “Selva Tucumano-Boliviana” or “Selva Tucumano-Oranense”. Biogeographically, Argentinean Yungas are in the Andean corridor and constitute practically the southeast expression of the Amazonic Domain (Cabrera 1994). About 50% of Argentina’s biodiversity can be found in this ecosystem (Brown et al. 2005). Tree diversity is high and preliminary estimations include more than 230 tree species with particular

elements of Holarctic (*Alnus*, *Berberis*, *Juglans*, *Sambucus*), Gondwanic (*Podocarpus*, *Escallonia*, *Weinmannia*), Pantropical (*Eugenia*, *Ocotea*) and Neotropical (*Myrcianthes*) origins (Grau & Brown 2000, Brown et al. 2005).

Argentinean Yungas are characterized by a high altitudinal gradient characterized by different environmental conditions such as periods of drought, high temperatures, high humidity levels, frosts and snow in winter, a fact that reflects a particular floristic composition. As result of the environmental gradient, three main forest types can be distinguished (Brown et al. 2005), namely: premontane lowland forests (400-700 m asl); lower montane forests (700-1500 m asl); and upper, temperate montane forests (1500-2500 m asl).

Argentinean Yungas have been under strong anthropogenic pressure for many decades (Grau & Brown 2000). In the meantime, the biodiversity of Argentinean Yungas is threatened by global climate changes and human activity such as agricultural frontier expansion, intense logging, and oil and gas prospecting (Grau & Brown 2000). These activities cause a variation in occurrence and abundance of woody substrates, thus possibly producing direct effects on the populations and communities of wood decomposers, as has been shown in forests of the Northern Hemisphere (Sippola & Renvall 1999). Despite the high endemic value of plants of Argentinean Yungas (Zuloaga et al. 1999), important ecological groups as wood-rotting fungi have not yet been surveyed.

Mycological knowledge state of Yungas

The heterogeneity and diversity of woody substrates of Argentinean Yungas forests suggest a rich wood-decaying fungal diversity and a complex community structure, with taxonomic novelties, including taxa awaiting to be described (Robledo et al. 2003). In the case of polypores, the study of their diversity in Argentina has been concentrated in: the subtropical rainforests and gallery forests of E and NE in the so-called (Argentinean) Mesopotamia and the capital city surrounding areas, Buenos Aires (Popoff 2000 and references therein), the humid and subxerophytic Chaco forests of north central Argentina and southern Paraguay (Popoff 2000), and the *Nothofagus*-dominated forests of Southern Argentina (Rajchenberg 2006). Several endemic and cosmopolitan taxa have been described recently from the particular *Polylepis* (*Rosaceae*) forests of central Argentina reviewed in Robledo et al. (2006). But the research undertaken in NW Argentina has been more sporadic. Spegazzini (1919) made the first studies and deposited collections in LPS, and during the following 80 years polypore studies in this region have been restricted to field trips headed by the mycologists Rolf Singer and Jorge E. Wright. Their collections are kept mainly at BAFC, LIL and LPS. Several works published in the last 25 years have dealt with specific polypore taxa and genera, or with particular substrates

(Bazzalo & Wright 1982, Gottlieb et al. 1998, 2002; Rajchenberg & Bianchinotti 1991, Rajchenberg 1982, 1985; Robledo et al. 2003, Ryvarden et al. 1982, Silveira & Wright 2005, Urcelay & Robledo 2004, Wright 1966, 1976) but, as yet, there is no comprehensive study on the polypores of that area.

The aim of this study was to establish a baseline of knowledge of polypore diversity in Argentinean Yungas, through the construction of an annotated checklist.

Material and methods

An intensive search of fungal records in literature was done. When possible we updated and/or corroborated the records (mainly those of Spegazzini) through the study of original specimens. Also, we revised all collections deposited in the herbaria CORD, LPS, LIL, CTES, and BAFC. Type and reference materials deposited in international herbaria were also checked. Herbarium acronyms are from Holmgren et al. (1990). Morphological features of basidiocarps were observed. Microscopic examinations and measurements were made from freehand sections mounted in 3-5% KOH plus 1% phloxine and in Melzer's reagent.

Results

We checked, studied, and/or revised a total of 850 collections. Together with the literature search we established the presence of **111** species. The current annotated checklist for the polypore species from Argentinean Yungas can be downloaded from <http://www.mycotaxon.com/resources/weblists.html>.

Masuka & Ryvarden (1999) have shown that the tropical genus *Megasporoporia* Ryvarden & J.E. Wright does not differ from the temperate *Dichomitus* D.A. Reid sufficiently enough to merit separate status. Therefore, we propose here the following new combination:

***Dichomitus hexagonoides* (Speg.) Robledo & Rajchenb. comb. nov.**

Mycobank # MB10615

Bas.: *Poria hexagonoides* Speg., An. Mus. Nac. Buenos Aires 6: 170, 1899 (LPS!).

= *Megasporoporia hexagonoides* (Speg.) J.E. Wright & Rajchenb., Mycotaxon 16: 176, 1982.

A 37 % (41 out of 111) of the species constitute novelties in distribution. The most interesting ones are the new records for South America of *Phellinus laevigatus* (Fr.) Bourdot & Galzin and *Skeletocutis stellae* (Pilát) Jean Keller. These species are well known in the North Hemisphere, viz., North America (Gilbertson & Ryvarden 1987), Europe (Ryvarden & Gilbertson 1994) and Asia (Núñez & Ryvarden 2000, 2001). No differences were observed with reference materials.

Eight rare species constitute new records for Argentina: *Amauroderma macrosporum* J.S. Furtado, *Amylosporus campbellii* (Berk.) Ryvarden,

Fomitopsis meliae (Underw.) Gilb., *Phellinus johnsonianus* (Murrill) Ryvarden, *Phellinus shaferi* (Murrill) Ryvarden, *Phylloporia capucina* (Mont.) Ryvarden, *Polyporus biskeletalis* Corner and *Skeletocutis nivea* (Jungh.) Jean Keller. All these taxa are known from other neotropical areas of South America.

Finally, 31 species are new records for the region, and a **Nomina incerta** of 25 names published by Spegazzini that require re-evaluation was established. Some combinations were not traced, representative materials were not found at the herbaria and there is no mention regarding their placement. In other cases the herbarium materials could not be identified because they were sterile or deteriorated.

Acknowledgements

Authors are grateful to the Curators of BAFC, CTES, LIL and LPS for the loan of materials under their keeping. Dr O. Popoff (CTES) is kindly acknowledged for his hospitality during the visit to his institution. Dr Leif Ryvarden and Dr Julieta Carranza are kindly acknowledged for their valuable suggestions and Dr S. Pennycook for his detailed review of nomenclatural problems. GLR is Fellow and MR Researcher of CONICET (National Research Council of Argentina). Research funded through grant CONICET-PIP 6195/05.

Literature cited

- Bazzalo ME, Wright JE. 1982. Survey of the Argentine species of the *Ganoderma lucidum* complex. *Mycotaxon* 16: 293–325.
- Brown AD, Pacheco S, Lomáscolo T, Malizia L. 2005. Ecorregión Yungas: Situación ambiental en los Bosques andinos Yungueños. In: Situación Ambiental Argentina 2005 (eds. A. Brown, U. Martínez Ortiz, M. Acerbi and J. Corcuera). Fundación Vida Silvestre Argentina, Argentina: 53–72.
- Cabrera AL. 1994. Regiones Fitogeográficas Argentinas. Enciclopedia Argentina de Agricultura y Jardinería. Tomo II. Editorial ACME S.A.C.I., Buenos Aires.
- Gilbertson RL, Ryvarden L. 1987. North American Polypores Vol. 2. Fungiflora, Oslo.
- Gottlieb AM, Saidman B, Wright JE. 1998. Isoenzymes of *Ganoderma* species from southern South America. *Mycological Research* 102: 415–426.
- Gottlieb AM, Wright JE, Moncalvo J. 2002. *Inonotus* s.l. in Argentina-morphology, cultural characters and molecular analyses. *Mycological Progress* 1: 299–313.
- Grau A, Brown A. 2000. Development threats to biodiversity and opportunities for conservation in the Muntain Ranges of the Upper Bermejo River Basin, NW Argentina and SW Bolivia. *Ambio* 29: 445–450.
- Holmgren P, Holmgren NL, Barnett LC. 1990. Index herbariorum. Part I: The herbaria of the world. New York Botanical Garden, New York: 1–693.
- Masuka AJ, Ryvarden L. 1999. *Dichomitus* in Africa. *Mycological Research* 103: 1126–1130.
- Núñez M, Ryvarden L. 2000. East Asian polypores 1. *Ganodermataceae* and *Hymenochaetaceae*. *Synopsis fungorum* 13: 1–168.
- Núñez M, Ryvarden L. 2001. East Asian polypores 2. *Polyporaceae* s. lato. *Synopsis fungorum* 14: 170–522.

- Popoff O. 2000. Novedades sobre "Corticoides" y "Políporos" (*Basidiomycetes*) xilófilos del nordeste argentino y Paraguay. Tesis de Doctorado. Universidad Nacional de Córdoba, Argentina.
- Rajchenberg M. 1982. El género *Coriolus* (*Polyporaceae*) en la República Argentina. Boletín de la Sociedad Argentina de Botánica 21: 17–57.
- Rajchenberg M. 1985. On *Trametes aethalodes* and other species of *Daedalea* (*Polyporaceae*). Canadian Journal of Botany 64: 2130–2135.
- Rajchenberg M. 2006. Los Políporos (*Basidiomycetes*) de los bosques Andino Patagónicos de Argentina. Bibliotheca Mycologica 201: 1–300.
- Rajchenberg M, Bianchinotti MV. 1991. *Trametes fumoso-avellanea* (*Aphylllophorales*, *Basidiomycetes*): a taxonomic study. Nordic Journal of Botany 11: 225–230.
- Robledo G, Urcelay C, Rajchenberg M, Domínguez L. 2003. Políporos (*Aphylllophorales*, *Basidiomycota*) parásitos y saprófitos de *Alnus acuminata* en el noroeste argentino. Boletín de la Sociedad Argentina de Botánica 38: 207–224.
- Robledo G, Urcelay C, Domínguez L, Rajchenberg M. 2006. Taxonomy, ecology and biogeography of polypores (*Basidiomycetes*) from Argentinian *Polylepis* woodlands. Canadian Journal of Botany 84: in press.
- Ryvarden L, Gilbertson RL. 1994. European Polypores Vol. 2. Fungiflora, Oslo.
- Ryvarden L, Wright JE, Rajchenberg M. 1982. *Megasporoporia*, a new genus of resupinate Polypores. Mycotaxon 16: 172–182.
- Silveira RM, Wright JE. 2005. The taxonomy of *Echinochaete* and *Polyporus* s. str. in southern South America. Mycotaxon 93: 1–59.
- Sippola A, Renvall P. 1999. Wood-decomposing fungi and seed-tree cutting: A 40-year perspective. Forest Ecology and Management 115: 183–201.
- Spegazzini C. 1919. Los Hongos de Tucumán. 1º reunión Nacional de la Sociedad Argentina de Ciencias Naturales 1916, 254–274.
- Urcelay C, Robledo G. 2004. Community structure of polypores (*Basidiomycota*) in Andean alder wood in Argentina: Functional groups among wood-decay fungi? Austral Ecology 29: 471–476.
- Wright JE. 1966. The genus *Phaeotrametes*. Mycologia 58: 529–540.
- Wright JE. 1976. *Loweporus*, a new genus of pore fungi. Memoirs of the New York Botanical Garden 28: 225–231.
- Zuloaga F, Morrone O, Rodríguez D. 1999. Análisis de la biodiversidad en plantas vasculares de la Argentina. Kurtziana 27: 17–167.

Phylogenetic relationships and nomenclature of *Bremiella sphaerosperma* (Chromista, Peronosporales)HERMANN VOGLMAYR¹ & MARCO THINES²

hermann.voglmayr@univie.ac.at

¹ Department of Systematic and Evolutionary Botany, University of Vienna
Rennweg 14, A-1030 Vienna, Austria

thines@uni-hohenheim.de

² Institute of Botany, University of Hohenheim
Garbenstrasse 30, D-70599 Stuttgart, Germany

Abstract—Molecular phylogenetic analyses using D1–3 and D7–8 nrLSU rDNA sequence data clearly show that *Bremiella sphaerosperma* is embedded within *Plasmopara* sensu stricto. Therefore, it is transferred to the genus *Plasmopara*; for nomenclatural reasons, we propose the new name *Plasmopara constantinescui*. Despite its distinct morphology, maximum parsimony and maximum likelihood analyses support a sister group relationship to *Plasmopara obducens*, the second downy mildew species parasitic of *Impatiens* spp. Both species were investigated and documented with scanning electron microscopy.

Key words—phylogeny, taxonomy, large subunit ribosomal DNA

Introduction

The genus *Bremiella* was described by Wilson (1914) for the North American *Peronospora megasperma* Berl. [= *Plasmopara megasperma*], a parasite of *Viola rafinesquii* Greene (= *Viola bicolor* Pursh) (*Violaceae*). The characters delimiting *Bremiella* from *Plasmopara* were considered to be dichotomous (vs. monopodial in *Plasmopara*) branching of the sporangiophore and pronounced terminal swellings of the sporangiophore tips (Wilson 1914, Constantinescu 1979, 1991). For a long time, *Bremiella* was considered to be monotypic, until Constantinescu (1979) transferred *Plasmopara baudysii*, a parasite of *Berula erecta* (Huds.) Coville (*Apiaceae*), to *Bremiella*. Subsequently, Tao & Quin (1982) placed three additional species parasitizing asteraceous hosts into *Bremiella* (*B. artemisiae-annuae* (L. Ling & M.C. Tai) J.F. Tao on *Artemisia annua* L., *B. chrysanthemicoronarii* (Sawada) J.F. Tao on *Chrysanthemum coronarium* L., and *B. multiformis* J.F. Tao & Y. Qin on *Chrysanthemum coronarium* L., *Crossostephium artemisioides*

Less. and *Artemisia annua*); however, after thorough morphological studies the species parasitizing *Asteraceae* were excluded from *Bremiella* and transferred to the genus *Paraperonospora* by Constantinescu (1989). Tao & Quin (1985) described *Bremiella oenanthae* J.F. Tao & Y. Qin from *Oenanthe* (*Apiaceae*), which, however, according to Constantinescu (1991) is morphologically indistinguishable from *Bremiella baudysii* (Skalický) Constant. & Negrean. At last, Constantinescu (1991) described a new species, *Bremiella sphaerosperma*, from *Impatiens* (*Balsaminaceae*) in eastern Russia and northeastern N-America. *Bremiella sphaerosperma* was shown to be morphologically and ecologically clearly distinct from *Plasmopara obducens*, a common, widely distributed parasite of several species of *Impatiens* in the Northern Hemisphere. Most of its morphological features favoured the inclusion in the genus *Bremiella*. However, already Constantinescu (1991) noted that *Bremiella sphaerosperma* shows some differences to *B. megasperma* and *B. baudysii* and that, after addition of *B. sphaerosperma*, the genus *Bremiella* became rather heterogeneous.

In recent molecular phylogenetic analyses of representative samples of downy mildews (including *Bremiella megasperma* and *B. baudysii*), using partial sequences of the large subunit of the nuclear ribosomal DNA (nrLSU rDNA), the species of *Bremiella* turned out to be polyphyletic but all embedded within the genus *Plasmopara* (Riethmüller et al. 2002, Göker et al. 2003, Voglmayr et al. 2004). Polyphyly of *Bremiella* within *Plasmopara* was also corroborated in a recent multigene analysis (Göker et al. 2007). In addition, morphological investigations of *B. megasperma*, the generic type, and *B. baudysii* showed that sporangiophore morphology may be rather interpreted as monopodial than strictly dichotomous. Therefore, there was little reason to maintain the genus *Bremiella*, which was consequently sunk into synonymy of *Plasmopara* (Riethmüller et al. 2002). As both *B. megasperma* and *B. baudysii* had previously been combined into *Plasmopara*, no formal nomenclatural changes were necessary. However, as a consequence of synonymizing the type species of *Bremiella* with *Plasmopara*, the third accepted species, *Bremiella sphaerosperma*, became an orphaned species with unclear generic attribution. Lack of recently collected material suitable for DNA investigations precluded statements on phylogenetic relationships of *B. sphaerosperma*, and nomenclatural transfer was consequently delayed.

During a collecting trip to the eastern USA in spring 2003, two fresh collections of *B. sphaerosperma* were made by the first author. This offered the opportunity to investigate *B. sphaerosperma* in detail and to clarify its generic attribution. As a result, both molecular and SEM data were collected, which are presented in the current publication.

Materials and methods

Specimens examined—*Bremiella sphaerosperma*: USA, Virginia, Wythe Co., N of Wytheville, Jefferson Natl. Forest, Stoney Fork Campground, moist mixed deciduous forest, on *Impatiens capensis* Meerb., 26 May 2003, Hermann Voglmayr H.V.-PA16 (WU). - South Carolina, Oconee Co., Mountain Rest, at the SC 28 near the border to Georgia, damp ditch in mixed deciduous forest, on *Impatiens capensis*, 19 May 2003, Hermann Voglmayr H.V.-PA4 (WU).

Plasmopara obducens: USA, Tennessee, Knox Co., Knoxville, Third Creek Park, on *Impatiens capensis*, 5 April 2000, Hermann Voglmayr H.V.-5.4.P.O.1 (WU). - Knoxville, Woodlot of Agricultural Sciences of the University of Tennessee (UTK), on *Impatiens capensis*, 5 April 2000, Hermann Voglmayr H.V.-5.4.P.O.2 (WU). - Austria, Oberösterreich, Distr. Grieskirchen, Comm. Natternbach, swamp forest SW Haibach, on *Impatiens noli-tangere* L., 24 May 1999, Hermann Voglmayr P-H.V.207 (WU). - Distr. Schärding, Comm. Kopfing, moist ravine forest ESE Grub, on *Impatiens noli-tangere*, 25 April 2000, Hermann Voglmayr P-H.V.307 (WU). - Germany, Baden-Württemberg, Distr. Göppingen, Comm. Gruibingen, on *Impatiens noli-tangere*, 6 May 2005, Marco Thines (HOH). - China, Yunnan, Kunming, Yunnan Agricultural University, on *Impatiens balsamina* L., 10 September 2004, Marco Thines (HOH).

Microscopy

For light microscopical (LM) studies slides were prepared in anhydrous lactic acid and/or water. For scanning electron microscopy (SEM) the samples were dried over silica gel for 24h, mounted on aluminium stubs, sputtered with an alloy of gold and palladium (80:20), and examined using a Zeiss DSM940 microscope at 5 kV at 8 mm distance to the object.

DNA-extraction, PCR and sequencing

The DNA extraction, PCR, cycle sequencing and sequencing of the nuclear large subunit (nrLSU) D1–3 and D7–8 regions are described in Göker et al. (2003). GenBank accession numbers for the sequences obtained are listed in Table 1.

Data analysis

For the phylogenetic analyses, the sequences of *Plasmopara obducens* and *Bremiella sphaerosperma* obtained in the present study were added to a representative taxon sample of *Peronosporaceae*. For this, the D1–3, 7–8 nrLSU rDNA sequence alignment of Göker et al. (2003) deposited at Treebase (www.treebase.org; M1589.nx) was used as basis (Table 1). Due to the lack of large indels, it was easily possible to manually align the sequences of the present study to the sequence alignment. 2177 characters of the resulting partial nrLSU alignment were included in the subsequent phylogenetic analyses. *Phytophthora arecae* and *P. litchii* were selected as outgroup species.

Maximum parsimony (MP) analysis of the sequence data was performed with PAUP* (version 4.0 b10; Swofford 2002), using 1000 replicates of heuristic search with random addition of sequences and subsequent TBR branch swapping (MULTREES option in effect, steepest descent option not in effect). All molecular characters were unordered and given equal weight; gaps were treated as missing data. Bootstrap analysis with 1000 replicates was performed in the same way, but using 10 rounds of random sequence addition and subsequent branch swapping during each bootstrap replicate.

For maximum likelihood (ML) analyses, first the appropriate model of sequence substitution was selected using Modeltest 3.6 (Posada & Crandall 1998); the model selected by the Akaike Information Criterion (AIC) was then implemented in the further analyses (Posada & Buckley 2004). Maximum likelihood analysis was performed with the fast likelihood software PhyML 2.4.4 (Guindon & Gascuel 2003), starting with a BioNJ tree (Gascuel 1997). Using the same program, a maximum likelihood bootstrap analysis was performed with 500 bootstrap replicates.

Table 1. Taxa and GenBank accession numbers of sequences used for phylogenetic reconstruction; those with collection numbers given in brackets and marked with an asterisk (*) were obtained during the present study, the others were taken from Göker et al. (2003).

Taxon (collection number)	GenBank accession numbers	
	D1–D3	D7–D8
<i>Basidiophora entospora</i> Roze & Cornu	AY035513	AY273990
<i>Bremia lactucae</i> Regel	AY035507	AY273984
<i>Bremiella sphaerosperma</i> Constant. (H.V.-PA4)	EF196868*	EF196871*
<i>Bremiella sphaerosperma</i> (H.V.-PA16)	EF196867*	EF196870*
<i>Hyaloperonospora brassicae</i> (Gäum.) Göker et al.	AY035503	AY273974
<i>Hyaloperonospora erophilae</i> (Gäum.) Göker et al.	AY271998	AY273972
<i>Hyaloperonospora lunariae</i> (Gäum.) Constant.	AY271997	AY273970
<i>Hyaloperonospora parasitica</i> (Pers.) Constant.	AY271996	AY273969
<i>Paraperonospora leptosperma</i> (de Bary) Constant.	AY035515	AY273989
<i>Peronospora aestivalis</i> Syd.	AY035482	AY273948
<i>Peronospora alpicola</i> Gäum.	AY271990	AY273953
<i>Peronospora boni-henrici</i> Gäum.	AY035475	AY273952
<i>Peronospora calotheca</i> de Bary	AY035483	AY273960
<i>Peronospora dentariae</i> Rabenh.	AY272000	AY273976
<i>Peronospora rumicis</i> Corda	AY035476	AY273951
<i>Peronospora trifolii-repentis</i> Syd.	AY271988	AY273945
<i>Peronospora trivialis</i> Gäum.	AY035471	AY273950
<i>Phytophthora arecae</i> (L.C. Coleman) Pethybr.	AY035530	AY273992
<i>Phytophthora litchii</i> (C.C. Chen ex W.H. Ko et al.) Voglmayr et al.	AY035531	AY273993
<i>Plasmopara baudysii</i> Skalický	AY035517	AY273985
<i>Plasmopara densa</i> (Rabenh.) J. Schröt.	AY035525	AY273983
<i>Plasmopara megasperma</i> (Berl.) Berl.	AY035516	AY273981
<i>Plasmopara nivea</i> (Unger) J. Schröt.	AY119604	AY273982
<i>Plasmopara obducens</i> (J. Schröt.) J. Schröt.	AY035522	AY273980
<i>Plasmopara obducens</i> (P-H.V.207)	EF196869*	EF196872*
<i>Plasmopara pimpinellae</i> Trevis. & O. Sävul.	AY035519	AY273988
<i>Plasmopara pusilla</i> (de Bary) J. Schröt.	AY035521	AY273979
<i>Plasmopara viticola</i> (Berk. & M.A. Curtis) Berl. & De Toni	AY035524	AY273978
<i>Plasmoverna pygmaea</i> (Unger) Constant. et al.	AY119605	AY273986
<i>Pseudoperonospora humuli</i> (Miyabe & Takah.) G.W. Wilson	AY035496	AY273965
<i>Pseudoperonospora urticae</i> (Lib.) E.S. Salmon & Ware	AY035497	AY273966

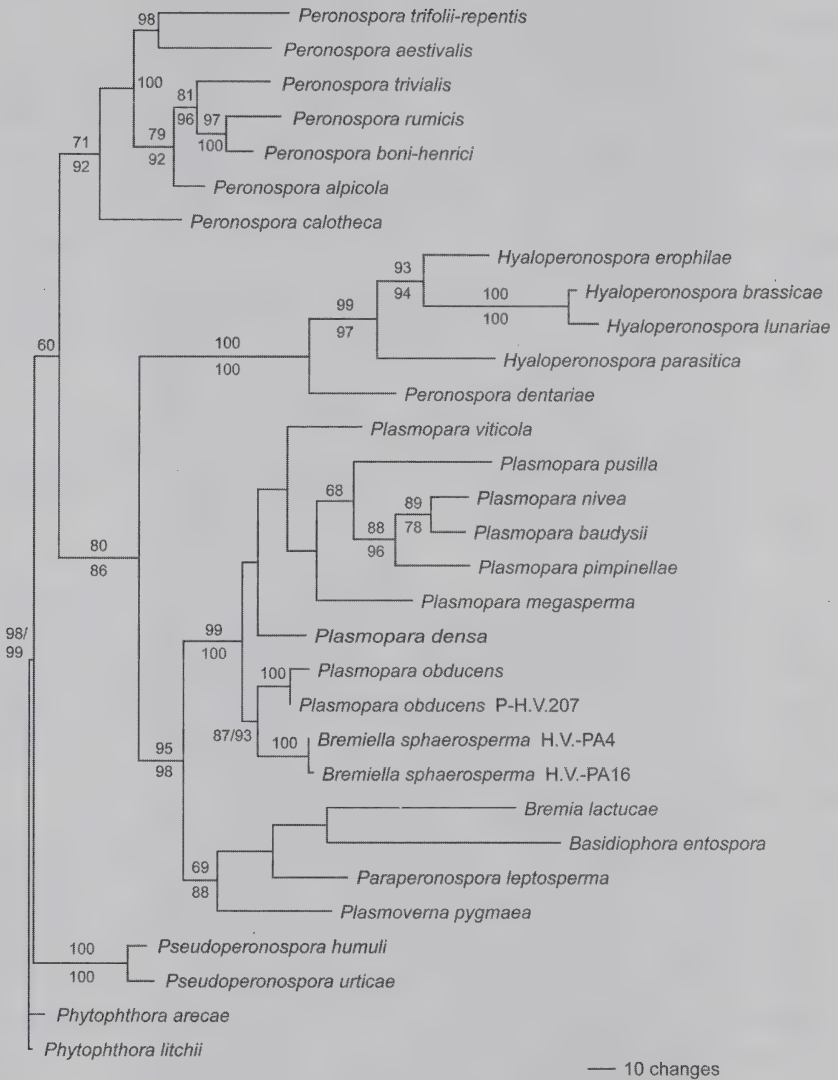


Figure 1. Most parsimonious tree revealed in a heuristic search (1000 replicates with random addition of sequences, TBR branch swapping) of the D1–3,7–8 nrLSU rDNA sequence alignment; numbers above branches/first number represent MP bootstrap values above 60% (1000 replicates, with 10 rounds of random sequence addition and subsequent branch swapping during each bootstrap replicate); below branches/second number ML bootstrap values above 70% (500 replicates using PhyML with GTR+I+G as substitution model).

Results

Molecular phylogeny

The result of the MP analysis is shown in Fig. 1. Of the 2177 characters, 333 were parsimony-informative, and one MP tree of score 1209 was obtained. For the ML analysis, the general time-reversible model was selected, additionally assuming a proportion of invariant sites with gamma-distributed substitution rates of the remaining sites (GTR+I+G; see Swofford et al. 1996). ML analysis revealed a tree largely compatible with the MP analysis except for a slightly different position of *Plasmopara densa* and *Basidiophora entospora* (tree not shown). Inclusion of *Bremiella sphaerosperma* within *Plasmopara sensu stricto* is highly supported in both ML and MP bootstrap analyses (Fig. 1); sister group relationship of *Bremiella sphaerosperma* and *Plasmopara obducens* is highly supported.

LM

Light microscopical investigations fully confirmed the results of the detailed investigations of Constantinescu (1991). Therefore, there is no need to repeat LM descriptions and illustrations here.

SEM

Sporangiophores of *Plasmopara obducens* are collapsed on herbarized material (Fig. 2A). Also the ultimate branchlets are usually collapsed, revealing an annulus at the slightly broadened tip (Fig. 2B). Sporangia show a dense ornamentation, which consists of irregularly shaped protuberances. These form an almost contiguous plate around the pedicel, with about 2.5–3.5 μm diam. (Fig. 2C). A papilla is mostly visible in SEM, although it is sometimes not easily detected.

The swelling of the annulate tips of the ultimate branchlets is very conspicuous in *Bremiella sphaerosperma* (Fig. 2F). The sporangiophores are hardly collapsed (Fig. 2E); especially the ultimate branchlets have retained their round shape (Fig. 2F). This is due to the remarkably thick wall of the sporangiophore in this species, which has already been noted by Constantinescu (1991). Sporangia are densely covered with irregularly shaped protuberances, which form a contiguous plate around the pedicel, about 3–4 μm diam. (Fig. 2G). A papilla is not or only hardly visible in SEM (Fig. 2H).

Discussion

The results of the phylogenetic analyses clearly demonstrate that *Bremiella sphaerosperma* belongs to the genus *Plasmopara* (Fig. 1). In addition, there is some evidence that *Bremiella sphaerosperma* may be closely related to *Plasmopara obducens*, despite the pronounced differences in sporangiophore morphology and ultrastructure; however, the taxon sampling for *Plasmopara*

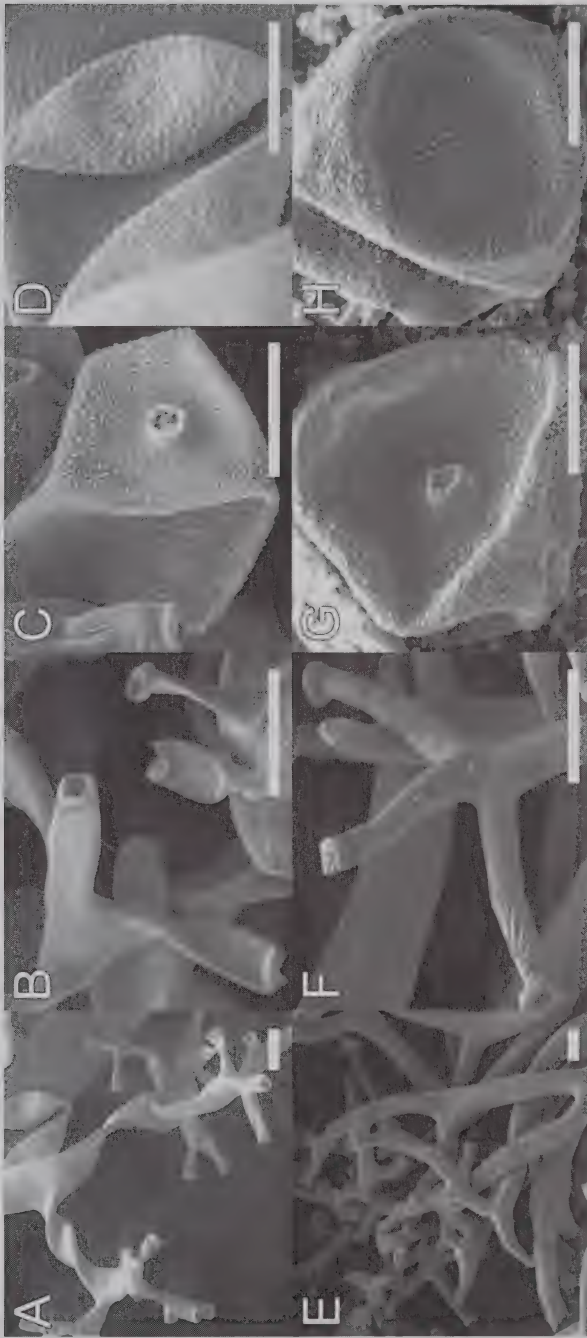


Figure 2. Characteristics of *Plasmopara obducens* (A-D) and *Bremiella sphaerosperma* (E-H) as seen in SEM. A, E: sporangiophores; B, F: ultimate branchlets; C, G: basal part of the sporangia; D, H: apical part of the sporangia. Bar = 5 μm in all pictures.

in the D1–3,7–8 nrLSU dataset is too small to make any definite statements. After addition of the *Bremiella sphaerosperma* sequences to the D1–2 LSU rDNA alignment of Voglmayr et al. (2004), sister group relationship did not receive significant support in subsequent MP and ML bootstrap analyses (data not shown). However, this may be due to the fewer characters available in the D1–2 alignment, and this reduced dataset is often unsuitable for evaluation of phylogenetic relationships within *Plasmopara* (Voglmayr et al. 2004).

Bremiella sphaerosperma again illustrates that sporangiophore morphology is not always indicative of phylogenetic relationships, and sporangiophore morphology may have been overestimated in previous classifications (Riethmüller et al. 2002, Voglmayr et al. 2004, Thines et al. 2006). Especially the subdivision into genera with dichotomous versus monopodial sporangiophore morphology does not pass detailed analyses, as both characters can intergrade, and unequivocal attribution is often dependent on subjective appraisal of the observer rather than on sound differences. This is also true for *Bremiella sphaerosperma* and, although at first sight the branching is apparently dichotomous, it can be interpreted as monopodial as well, if the term monopodial is not restricted to branching at more or less right angles.

Besides the branching of the sporangiophore, the main characteristic of *Bremiella* was thought to be the broadening of the tips of the ultimate branchlets. However, this feature is not restricted to the downy mildews previously classified in *Bremiella*, but is found in almost any species of the downy mildews with pyriform, globose or ellipsoid haustoria (DMPH). This has been revealed through SEM investigations of the genera of the *Peronosporaceae* (Thines 2006). The distal broadening of the ultimate branchlets is mostly caused by an annulus at the sporangiophore tip, which often has a significantly larger diameter than the trunk of the ultimate branchlet. This characteristic is depicted for *Plasmopara nivea* and *Plasmoverna pygmaea* by Constantinescu et al. (2005). Hence, molecular genetic similarity with *Plasmopara* species and the lack of genus specific morphological features favours the relegation of *Bremiella* into synonymy with *Plasmopara*.

Taxonomy

Transfer of *Bremiella sphaerosperma* into *Plasmopara* necessitates the proposal of a nomen novum, as the epithet is already occupied by *Plasmopara sphaerosperma* (Săvulescu 1941), the basionym of *Protobremia sphaerosperma* (Săvul.) Voglmayr et al. (Voglmayr et al. 2004).

***Plasmopara constantinescui* Voglmayr & Thines, nom. nov.**

MYCOBANK MB 510528

Replaced synonym: *Bremiella sphaerosperma* Constant., Mycologia 83: 473, 1991 [non *Plasmopara sphaerosperma* Săvul., Bulletin de la Section Scientifique de l'Académie Roumaine 24: 65–66, 1941]

Etymology: named after Ovidiu Constantinescu to honour his important contributions to downy mildew systematics and taxonomy.

Acknowledgements

Walter Gams is gratefully acknowledged for giving nomenclatural advice and his pre-submission review, and Otmär Spring for his pre-submission review.

Literature cited

- Constantinescu O. 1979. Revision of *Bremiella* (*Peronosporales*). Transactions of the British Mycological Society 72: 510-515.
- Constantinescu O. 1989. *Peronospora* complex on *Compositae*. Sydowia 41: 79-107.
- Constantinescu O. 1991. *Bremiella sphaerosperma* sp. nov. and *Plasmopara borrieriae* comb. nov. Mycologia 83: 473-479.
- Constantinescu O, Voglmayr H, Fatehi J, Thines M. 2005. *Plasmoverna* gen. nov., and the nomenclature and taxonomy of *Plasmopara* (*Chromista*, *Peronosporales*). Taxon 54: 813-821.
- Gascuel O. 1997. BIONJ, an improved version of the NJ algorithm based on a simple model of sequence data. Molecular Biology and Evolution 14: 685-695.
- Göker M, Voglmayr H, Riethmüller A, Weiß M, Oberwinkler F. 2003. Taxonomic aspects of *Peronosporaceae* inferred from Bayesian molecular phylogenetics. Canadian Journal of Botany 81: 672-683.
- Göker M, Voglmayr H, Riethmüller A, Oberwinkler F. 2007. How do obligate parasites evolve? A multi-gene phylogenetic analysis of downy mildews. Fungal Genetics and Biology 44 (in press).
- Guindon S, Gascuel O. 2003. A simple, fast, and accurate algorithm to estimate large phylogenies by maximum likelihood. Systematic Biology 52: 696-704.
- Posada D, Buckley TR. 2004. Model selection and model averaging in phylogenetics: advantages of the AIC and Bayesian approaches over likelihood ratio tests. Systematic Biology 53: 793-808.
- Posada D, Crandall KA. 1998. Modeltest: testing the model of DNA substitution. Bioinformatics 14: 817-818.
- Riethmüller A, Voglmayr H, Göker M, Weiß M, Oberwinkler F. 2002. Phylogenetic relationships of the downy mildews (*Peronosporales*) and related groups based on nuclear large subunit ribosomal DNA sequences. Mycologia 94: 834-849.
- Săvulescu T. 1941. Die auf Compositen parasitierenden *Plasmopara*-Arten. Bulletin de la Section Scientifique de l'Académie Roumaine 24: 45-67.
- Swofford DL, Olsen GJ, Waddell PJ, Hillis DM. 1996. Phylogenetic inference. In: Hillis DM, Moritz C, Mable BK. (eds.), Molecular Systematics. Sinauer Associates: Sunderland (Mass., USA). pp. 407-514.
- Swofford DL. 2002. PAUP*: Phylogenetic analysis using parsimony (*and other methods), Version 4.0 b10. Sinauer Associates, Sunderland, Massachusetts.
- Tao J-F, Qin Y. 1982. New species and new combinations of the genus *Bremiella* on *Compositae* of China. Acta Mycologica Sinica 1: 61-67. [In Chinese]
- Tao J-F, Qin Y. 1985. Taxonomic studies on the genus *Bremiella* in China. II. New species of *Bremiella* on *Umbelliferae*. Acta Mycologica Sinica 4: 12-15.
- Thines M. 2006. Evaluation of characters available from herbarium vouchers for the phylogeny of the downy mildew genera (*Chromista*, *Peronosporales*), with focus on scanning electron microscopy. Mycotaxon 97: 195-218.

- Thines M, Göker M, Spring O, Oberwinkler F. 2006. A revision of *Bremia graminicola*. Mycological Research 110: 646-656.
- Voglmayr H, Riethmüller A, Göker M, Weiss M, Oberwinkler F. 2004. Phylogenetic relationships of *Plasmopara*, *Bremia* and other genera of downy mildew pathogens with pyriform haustoria based on Bayesian analysis of partial LSU rDNA sequence data. Mycological Research 108: 1011-1024.
- Wilson GW. 1914. Studies in North American *Peronosporales* – VI. Notes on miscellaneous species. Mycologia 6: 192-210.

Five lichens new to Turkey

KENAN YAZICI*

kcagri_1997@yahoo.com

Karadeniz Technical University, Giresun Sciences and Arts Faculty,
Biology Department, Giresun, Turkey

ANDRÉ APTROOT

andreaptroot@wanadoo.nl

Adviesbureau voor Bryologie en Lichenologie
G.v.d. Veenstraat 107, NL-3762 XK Soest, The Netherlands

Abstract—Five species of lichenized fungi – *Arthonia didyma*, *Arthopyrenia cinereopruinosa*, *Arthopyrenia salicis*, *Lecania cyrtellina* and *Opegrapha niveoatra* – are new to Turkey. The latter two are also new to Asia. For each, a short description is presented.

Keywords—*Ascomycetes*, biodiversity, Bursa, Zonguldak

Large parts of the lichen flora of Turkey are still unknown. In recent years, however, there has been a substantial increase in the number of lichenological papers referring to Turkey (Aslan 2000, Aslan et al. 2002a,b, John 1996, John & Breuss 2004, John et al. 2000, Yazıcı & Aslan 2002, 2003, 2005, 2006a, Yazıcı et al. 2004, 2005). The present paper is a further contribution to this. In previous studies, Yazıcı reported 78 species from Karacabey county in Bursa (Yazıcı 1999) and 29 different species from Zonguldak (Yazıcı & Aslan 2006b, Çobanoğlu 2005, Verseghe 1982, Szatala 1960, John 1992).

The present report is based on collections from the two different provinces Bursa and Zonguldak between 04 and 29 August 2005. A stereo microscope, a light-microscope and the usual spot tests were used to identify the samples with reference to Purvis et al. (1992) and Wirth (1995). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Giresun University.

Results

Arthonia didyma Körb.

Thallus crustose, to 6.5–7.0 mm diam, inconspicuous, immersed, mostly effuse, wide-spreading or sometimes in tiny patches, pale, fawn to pinkish or

olive-grey evanescent. Apothecia $0.08\text{--}0.30 \times 0.06\text{--}0.30$ mm long, rounded to linear, fleck-like, flat, purple to blackish, not pruinose; epithecium red-brown, sometimes indistinct; hymenium $30\text{--}45$ μm tall, colourless; hypothecium $10\text{--}35$ μm tall, red-brown; the red-brown pigmented, K + grey or olivaceous, but epithecium, hymenium and sometimes hypothecium contain an orange-red, K + purple-violet pigment. Paraphysoids rather scanty, sometimes brown-walled a few with apical caps. Ascospores $13\text{--}15 \times 4\text{--}7$ μm , 1-septate, ovoid, colourless but later brown and warted. Pycnidia rare, immersed, K + olive-grey; conidia bacilliform.

Arthonia didyma is a suboceanic, cool-temperate species, growing usually on smooth bark of deciduous trees and shrubs in humid areas, especially *Corylus*, mainly in woodlands; common in unpolluted areas.

Known throughout Europe (British Isles, Czech Republic, Germany, Denmark, Sweden, Ireland, Italy, France, Romania, Norway, Poland the Netherlands, Lithuania, Estonia, Slovenia), eastern North America, New Zealand and Asia (e.g. Thailand, Japan). In the Mediterranean, it has been recorded from Calabria and Puglia, in southern Italy. New to Turkey.

Zonguldak: Ereğli county; on previously built Ereğli road, Ilıksu district, roadside on *Ulmus* sp., 100 m., $41^\circ 23' 20''$ N, $31^\circ 40' 35''$ E, 16 August 2005, Yazıcı 1283.

About survey area—This area has a typical oceanic climate and lies 500 m from the Black Sea and 10m from a stream. Droughts are not seen in climate type. Rainy days occur in every season and the most rainy days in autumn and winter. Rainfall average is 1234.96 mm per year, with the highest precipitation occur in December (148.65 mm) and January (141.72 mm). The lowest relative humidity is 70 % and the average relative humidity is 75 %.

Remarks—*Arthonia didyma* is similar to *A. spadicea* and *A. vinosa*. A red-brown or sometimes indistinct epithecium helps to differentiate *A. didyma* from the other species, which always have an indistinct epithecium. Apothecial sections have K + purplish pigments in *A. spadicea* and *A. vinosa*, but those in *A. didyma* have sometimes K + purple-violet pigment. *A. didyma* and *A. vinosa* have brown ascospores when old, but those in *A. spadicea* are colourless. Apothecia in *A. vinosa* and *A. spadicea* are rounded and convex while those in *A. didyma* are flat, fleck-like, or shortly linear. The thallus in *A. didyma* is pale brown in contrast to the orange tinge or stain in *A. vinosa*.

Arthopyrenia cinereopruinosa (Schaer.) A. Massal.

Thallus non-lichenized, to 1.7cm diam., inconspicuous or slightly bleaching the bark, gray-white towards thalline exciple gray-white, mostly light brown in the center of the thallus, shining. Perithecia $0.40\text{--}0.50 \times 0.15\text{--}0.40$ mm, circular or ellipsoid, often covered by a thin layer of bark cells giving a whitish pruinose

appearance. Pseudoparaphyses 1–1.5 μm wide, distinct, persistent, slender. Asci 50–75 $\times$ 10–20 μm , cylindrical–clavate. Ascospores 14–24 $\times$ 6–9 μm , usually colorless, clavate, with rounded apices, 1-septate, constricted at the septum and each cell biguttulate; perispore distinct. Pycnidia 60–100 μm diam., with either macro- or microconidia. Macroconidia 8–11 $\times$ 1.8–2.3 μm , bacilliform; microconidia 4.5–6 $\times$ 1 μm , bacilliform. Photobiont *Trentepohlia*.

This temperate species grows on smooth bark, in clearing of long-established woodlands near rivers especially on young twigs of *Fraxinus*.

Known throughout Europe (e.g. British Isles, Ireland, Norway, Germany, Austria, Romania, Finland, Estonia, Spain, Slovenia), Asia, Australia and North America. New to Turkey.

Bursa: Karacabey county; Bayamdere village, on base of young *Fraxinus excelsior*, 15 m, 40° 22' 45" N, 28° 24' 15" E, 29 August 2005, Yazici 1286.

About survey area—The site is flat and agricultural, 700 m from the Marmara Sea, shaded, occasionally exposed to strong winds, and with some deciduous trees present. The continental and cool Mediterranean climate is mild and cool in summer. Rainfall averages 668 mm per year, the highest precipitation occurring in January (94 mm) and December (118 mm), and the lowest in July (16 mm) and August (18 mm). Normally the highest annual temperature occurs in July, 23.6 °C, the lowest in January (4.9 °C). Humidity is high, averaging 73%.

Remarks—*A. cinereopruinosa* is close to *A. analepta*, which differs by producing thread-like and $\pm$ straight conidia, in somewhat smaller ascomata and ascospores, and bacilliform conidia. The median constriction characterizing mature ascospores of *A. cinereopruinosa* are absent in *A. analepta*. In addition *A. cinereopruinosa* possesses perithecia often covered by a thin layer of bark cells giving a whitish pruinose appearance.

Arthopyrenia salicis A. Massal.

Thallus often inconspicuous, sometimes to 15–20 mm diam, pale light-brown, sometimes pinkish when fresh, rarely dark brown. Perithecia numerous, 0.10–0.25 $\times$ 0.10–0.20 mm, to 0.3 deep, circular or ellipsoid, often with depressed ostiole, mostly crowded over the thallus; involucrellum remaining brown in K. Pseudoparaphyses absent; periphysoids 6–15 $\times$ 1–1.5 μm , obpyriform. Ascospores (11–)13–17(–20) $\times$ 4–5 μm , 1-septate, constricted at the septum, each cell biguttulate, the lower cell often with a median constriction, the apices rather blunt; perispore indistinct. Pycnidia c. 60 μm diam.; conidia 3–3.5 $\times$ 1 μm , $\pm$ bacilliform.

Arthopyrenia salicis is a temperate species that colonizes the smooth bark of deciduous trees and shrubs, *Carpinus* and *Corylus*. It is most frequent in upland areas.

Known throughout Europe (e.g. British Isles, Italy, Ireland, Norway, the Netherlands, Denmark, Germany, Slovenia), Asia (e.g. New Guinea) and North America. New to Turkey.

Bursa: Karacabey county; Bayramdere village, on young *Fraxinus excelsior*, 15 m, 40° 22' 45" N, 28° 24' 15" E, 29 August 2005, Yazıcı 1287.

About survey area—This species was found on the same habitat together with *Arthopyrenia cinereopruinosa* at the same station. So two species can colonize on the same habitat and are exposed the same climate.

Remarks—*Arthopyrenia salicis* resembles *Naetrocymbe punctiformis*. Indistinct perispores, bacilliform conidia, smaller asci and ascospores, and larger ascomata help differentiate *A. salicis* from *N. punctiformis*. In addition, *Naetrocymbe punctiformis* possesses pseudoparaphyses, but lacks the periphysoids that are present in *A. salicis*.

***Lecania cyrtellina* (Nyl.) Sandst.**

Thallus crustose, to 5–8 mm in diam, inconspicuous or continuous, partly effuse, rather smooth, very thin, pale green to dull greenish grey. Apothecia pale–pink to brownish or sometimes piebald, closely adpressed, $\pm$ sessile, to 0.10–0.25 diam, often crowded mostly over center of the thallus; generally discs flat, margin persistent, light pink–white, partly irregular, hymenium 25–35 μ m tall. Ascospores 7–12(–14) $\times$ 2–4 μ m. Microconidia (11–)14–16(–17) $\times$ 0.5 μ m, curved; microconidia 10–15(–18) $\times$ 1.5(–2) μ m, 0– to 1-septate, curved, crescent-shaped.

This holarctic lichen grows on the base-rich bark of isolated trees, such as *Populus*, *Juglans*, *Fraxinus*, *Sambucus*.

Known throughout Europe (e.g. England, Scotland, Belgium, northern France, Germany, Norway, Austria, Luxembourg), Macaronesia, Africa and North America. New to Asia.

Zonguldak: Devrek county; Karacaören, on *Quercus* sp., 500 m, 41° 18' 10" N, 31° 57' 40" E, 04 August 2005, Yazıcı 1291.

About survey area—This area has *Quercus* trees and has a typical oceanic climate. It is not near to the Black Sea. Winds are very strong, the site is shaded, and the slopes are very steep. Rainfall averages is 1234.96 mm per year and occurs in every season. Humidity is high (75 %).

Remarks—*Lecania cyrtellina* is close to *L. cyrtella*, which is mostly associated with *Xanthorion* and which has broader ascospores and longer microconidia.

***Opegrapha niveoatra* (Borrer) J.R. Laundon**

Thallus thin, superficial, sometimes minutely rimose or smooth, effuse, occasionally inconspicuous, upper surface smooth, light white or dull grey,

sometimes olive-brown mostly towards the thalline exciple. Apothecia (0.15–) 0.20–0.85(–1) × 0.10–0.20 mm, small, sessile, scattered or contiguous, simple, curved-sinuate or ± stellate, occasionally branched; disc at first a slit, becoming partially exposed with age; exciple somewhat uneven, K ± olivaceous in section, epithecium brown; hymenium 45–65 µm tall, I + red. Ascospores 25–30 × 2–4 µm, 4–7 septate, ± acicular. Conidia short and curved. 4–7(–8) × 1–1.5 µm and 7–8 × 0.7 µm. Thallus Pd–, K–, KC–, C–, UV–.

Opegrapha niveoatra is a mild-temperate species, growing on old neutral and basic deciduous bark, particularly *Acer*, *Fraxinus* and *Ulmus*, roadside and open woodland situations, more rarely on conifers and wood. It is also found coast of Spain, Morocco where microclimate is sufficiently humid and from a few littoral localities of Sardinia (from 300 to 900m).

Known throughout Europe (e.g. British Isles, Ireland, Belgium, northern France, Norway, Portugal, the Netherlands, Denmark, Sweden, Italy, Luxembourg, Slovenia, Spain, Estonia), Macaronesia (e.g. Azores), Africa (e.g. Algeria) and North and Central America. New to Asia.

Zonguldak: Ereğli county; on previously built Ereğli road, Ilısu district, roadside, on *Ulmus* sp., 100 m, 41° 23' 20" N, 31° 40' 35" E, 16 August 2005, Yazici 1283.

About survey area—This species was found on the same habitat together with *Arthonia didyma* in the same station.

Remarks—*Opegrapha niveoatra* differs from *O. vulgata* in having shorter and curved conidia (4–7 × 1–1.5 µm or 6–8 × 0.6–0.7 µm) and smaller apothecia.

Acknowledgements

We are grateful to Dr. Paolo Giordani, Dr. Christian Printzen and Dr. Pieter van den Boom for linguistic revision and helpful comments on an earlier draft of this paper.

References

- Aslan A. 2000: Lichens from the Regions of Artvin, Erzurum and Kars (Turkey). *Israel J. Plant Sci.* 48: 143–155.
- Aslan A, Yazıcı K, Karagöz Y. 2002a: Lichen Flora of the Murgul District (Artvin, Turkey) *Israel J. Plant Sci.* 50: 77–81.
- Aslan A, Aptroot A, Yazıcı K. 2002b: New lichens from Turkey. *Mycotaxon* 84: 277–280.
- Çobanoğlu G. 2005: Lichen collection in the Herbarium of the University of İstanbul (ISTF). *Türk J. Bot.* 29: 69–74.
- John V. 1992: Flechten der Türkei III. Die Flechten der Pilotkartierung für Europa in der Türkei. *Pollichia*, Pfalzmuseum für naturkunde, Bad Dürkheim 1–20
- John V, Breuss O. 2004: Flechten der Östlichen Schwarzmeer-Region in der Türkei (Blam-Exkursion 1997). *Herzogia* 17: 137–156.
- John V, Seaward MRD, Beatty J.W. 2000. A neglected lichen collection from Turkey. *Berkamsted School expedition 1971. Turk. J. Bot.* 24: 239–248.

- John V. 1996: Preliminary catalogue of lichenized and lichenicolous fungi of Mediterranean Turkey. *Boccone* 6: 173–216.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992: The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.
- Szatala Ö. 1960: Lichens Turcicae asiaticae ab Victor Pietschmann collecti. *Sydowia* 14: 312–325.
- Versegny KP. 1982: Beiträge zur Kenntnis der türkischen Flechtenflora. *Studia Bot. Hun.* 15: 53–65.
- Wirth V. 1995: Die Flechten Baden Württembergs. Teil 1–2. Ulmer, Stuttgart.
- Yazıcı K. 1999. Lichen Species in the North of Karacabey county, Bursa province, Turkey. *Turk. J. Bot.* 23: 271–276.
- Yazıcı K, Aslan A. 2002: New records for the lichen flora of Turkey. *Turk. J. Bot.* 26: 117–118.
- Yazıcı K, Aslan A. 2003: Lichens from the Regions of Gümüşhane, Erzincan and Bayburt (Turkey). *Cryptogamie, Mycol.* 24: 287–300.
- Yazıcı K, Aslan A. 2005: Six new lichen records from Turkey. *Mycotaxon* 93: 359–363.
- Yazıcı K, Aslan A. 2006a: Lichen taxonomic composition from MustafaKemalpaşa, Bursa district (Turkey). *Acta Bot. Croat.* 65(1): 25–39.
- Yazıcı K, Aslan A. 2006b: Four New lichens from Turkey. *Mycotaxon* 95: 315–318.
- Yazıcı K, Aslan A, Aptroot A. 2004: Four new lichen species from Turkey. *Mycotaxon* 90: 177–180.
- Yazıcı K, Aslan A, Aptroot A. 2005: New lichen records from Turkey. *Mycotaxon* 92: 341–344.

Typification and description of *Typhula buxi*I. OLARIAGA¹, M.P. HOYO², A. GÓMEZ-BOLEA² & I. SALCEDO¹

gvbolibi@lg.ehu.es

¹ Plant Biology and Ecology Dept. (Botany), University of the Basque Country
Apdo. 644, E-48080 Bilbao (Spain)² Dept. Biologia Vegetal (Botànica). Fac. Biologia. Universitat de Barcelona
Av. Diagonal, 645. E-08028 Barcelona (Spain)

Abstract—A *Typhula* resembling *T. erythropus* was collected on dead leaves of *Buxus sempervirens* at several localities of the Northeastern Iberian Peninsula. It was identified as *T. buxi*, a species only once collected since Maire described it from the Iberian Peninsula. As no original collection is conserved, the sclerotial structure of *T. buxi* was unknown; it was not described in the protologue. Later, however, the species was assigned to the subgenus *Cnazonaria*, which contains species with sclerotia with an inverse epidermoid layer, but the material studied in this work has a normal epidermoid layer. Concerning its typification, amongst the elements cited in the protologue, the illustration given in the protologue is selected as lectotype. In order to interpret it correctly and include *T. buxi* in the subgenus *Microtyphula*, which contains species with normal epidermoid layer, material from the type location is proposed as epitype in this work. In addition, a detailed description and illustrations of *T. buxi* are given and a comparison with *T. erythropus* is made.

Key words—Basidiomycota, taxonomy, ecology, Typhulaceae

Introduction

The genus *Typhula* (Pers.) Fr. includes about 68 species that are characterized by their small and clavarioid basidiomata, arising or not from a sclerotium (Berthier 1974). Despite being a genus of wide distribution, most of the species are restricted to temperate regions (Berthier 1976). *Typhula* was created by Persoon (1801) to designate some species within the genus *Clavaria*. Later, Fries (1818) considered *Typhula* a different genus, which included small species with a distinct clavula. On the other hand, *Pistillaria* was created to include small species with indistinct stipe and without sclerotia (Fries 1821).

Typhula and *Pistillaria* were widely used in the sense of Fries until Karsten (1882) used the name *Typhula* for the sclerotia-bearing species and *Pistillaria* for the non-bearing ones. Both Remsberg (1940) and Berthier (1976) proved

this classification to be artificial, since some species can develop sclerotia or not. Remsberg (1940), however, was the first to describe the sclerotial structure. Furthermore, she considered it to possess a high taxonomic value.

Corner (1950) subsequently divided the genus into two subgenera according to the observations of Remsberg (1940). In this context, Berthier (1974) studied in detail the sclerotial structure. On the one hand, the outer layer of hyphae of the sclerotium was called epidermoid layer, which can be normal or inverse. On the other hand, he paid attention to the ornamentation and presence of cutis of the epidermoid layer, which can display a high interspecific variability. The gelification of the medulla of the sclerotium became also an important characteristic. Berthier (1974) used those sclerotial characters and the morphology of the basidiomata to propose a new classification. However, taxa whose sclerotial structure is unknown cannot be included reliably in Berthier's classification, as occurs with *Typhula buxi* and other species.

T. buxi was originally described from Catalunya by Maire (1933), who discovered it living on dead leaves of *Buxus sempervirens*. Some years later Malençon & Bertault (1968) recorded the species from Morocco, growing on *Buxus balearica* leaves. Since no specimens of *T. buxi* were kept at the herbarium of Maire at MPU, Corner (1950), Pilát (1958), Berthier (1976) and Jülich (1984) based their descriptions solely on Maire's protologue. Despite not knowing its sclerotial structure, Berthier (1976) included it in the subgenus *Cnazonaria*, which contains species with inverse epidermoid layers. He did not report or check the material from Morocco.

Apart from the report from Malençon & Bertault (1968), no further material of *T. buxi* was collected until Hoyo & Gómez-Bolea (2003) rediscovered it in several localities of the northeastern Iberian Peninsula, including the type locality, again growing on dead leaves of *Buxus sempervirens*. Examinations of those collections revealed *T. buxi* to be a species producing sclerotia with normal epidermoid layers. Therefore, we consider it necessary to select a type for *T. buxi*, in order to permit its correct interpretation, together with an adequate taxonomic position. In our descriptions, we pay particular attention to the sclerotial structure and compare features found in the collections with those described in the original protologue.

Materials and methods

Herbaria are abbreviated according to Holmgren & Holmgren (1998). The collections examined in this study are deposited in BCN, BIO and UPS herbaria. The macroscopic descriptions are based on both fresh and dried material. Colour codes are from Munsell (1994). The adopted terminology follows both Berthier (1976) and Kirk et al. (2001). Melzer's reagent was used to check for

the amyloid and dextrinoid reactions. Microscopic measurements were made in Congo Red in KOH 5%. Basidiospore measurements were made in side view. Letter abbreviations describing basidiospore size are: X = mean length $\times$ mean width, Q = mean length/width ratio. 25 basidiospores were measured per collection. Basidia measurements exclude the sterigmata.

Taxonomy

Typhula buxi Maire, Treb. Mus. Cien. Nat. Barcelona 15(2): 28. 1933.

LECTOTYPE (designated here): Figure 4 in Maire, Treb. Mus. Cienc. Nat. Barcelona 15(2): 28. 1933.

EPITYPE (designated here): Collection BCN-Hoyo 128 deposited in BCN. Fig. 1 A, B and C.

Description

Basidioma 1.5-8(-14) mm long, stipe and clavula well delimited. **Clavula** (0.2-) 0.5-2(-8) $\times$ (0.05-)0.1-0.2(-0.33) mm, cylindrical to claviform, straight or curved, not branched, apex blunt, rarely subacute, greyish white (5Y 8/1, 8/2), yellowish grey (5Y 7/1, 7/2), or pale ochre (10YR 8/3, 8/4) when fresh, ochre (10YR 6/4, 6/6, 7/6, 7/4), brown (5YR 5/4; 7.5YR 4/4, 3/3, 5/8; 10YR 5/8, 4/6) or olive brown (2.5Y 5/6, 5/4, 4/4; 5Y 4/4) when dried. **Stipe** longer than the clavula, (0.7-)1.5-12.5 $\times$ 0.05-0.2 mm, cylindrical, sometimes widened at the base ($\times$ 0.15-0.3 mm), sinuous, rarely branched, greyish white (5Y 8/1, 8/2) near the clavula, ochre (10YR 6/4, 6/6, 7/6, 7/4) or light brown (7.5 YR 5/8; 10YR 5/8) when dried, progressively darker brown downwards (5YR 3/3; 2.5 YR 2.5/3; 7.5 YR 3/3), pubescent or glabrous. Caulinar hairs only on the apex or throughout the stipe.

Sclerotium single, immersed or erumpent, lenticular to subglobose, 0.2-1 mm diam., slightly wrinkled, pale brown (10YR 6/4, 7/4) or ochre (10YR 7/6) when fresh, dark brown (2.5 YR 2.5/2, 2.5/3, 3/4, 3/6, 4/6; 5YR 2.5/2, 4/6) when dried. 1(-2) basidioma per sclerotium.

Medulla of the clavula formed by parallel arranged hyphae, 4-16 μ m thick, cylindrical to slightly swollen, thin-walled, clamped, non-gelified, without crystals. **Hymenium** non-gelified. **Basidiospores** ellipsoidal, sometimes suballantoid, amyloid, (7-)7.5-9.5 $\times$ (3-)3.5-4.5(-5) μ m (X=7.17-8.90 $\times$ 3.22-4.21 μ m; Q = 1.90-2.51). **Basidia** claviform, 4(-2)-spored, clamped, 15-32 $\times$ 5-7.5 μ m. Sterigmata 3-4.5 μ m long. **Subhymenial hyphae** branched, cylindrical, 2.5-4 μ m thick, thin-walled, non-gelified, clamped.

Stipe surface formed by cylindrical hyphae, 3-6 μ m thick, thick-walled, clamped, sometimes secondarily septate, non-gelified but tightly cohesive, hyaline near the apex, brown downwards, with crystals. **Caulinar hairs** abundant,

cylindrical, often with widened base, seldom cylindrical, sinuous, thick-walled towards the base of the stipe, sometimes septate, sometimes branched, hyaline, yellowish at the base, rarely with crystals, $(10\text{--}45\text{--}95\text{--}140) \times 1.2\text{--}2.5 \mu\text{m}$ ($3\text{--}8.5 \mu\text{m}$ at the base). Crystals often present on the whole surface of the basidioma, bipyramidal or aggregate. Sclerotia non-gelified, with a normal epidermoid, without cutis. Epidermoid layer made up of hyphae with sinuous outline, thin to thick-walled, golden-brown. Medulla formed by non-gelified hyphae, $4\text{--}12 \mu\text{m}$ thick, thin to slightly thick-walled, without crystals.

SPECIMENS EXAMINED—*Typhula buxi* — SPAIN. BARCELONA: SEVA, CORRAL DE TERRERS, 31TDG43, 910 m, fallen leaves of *Buxus sempervirens*, 10/III/2001, Llimona, BCN-Hoyo 81. VIDRÀ, LA VILA VELLA, 31TDG46, 1030 m, dead leaves on a twig attached to a living *Buxus sempervirens*, 28/IX/2002, Hoyo & Ramírez, BCN-Hoyo 128 (EPITYPE). CUENCA: FUENTE DE LA BOTA, VILLAR DEL HUMO, 30SXK11, 980 m, dead leaves, on dead twig attached to a living plant, of *Buxus sempervirens*, 13/X/2001, Hoyo, BCN-Hoyo 40. GIRONA: CAMPOLLES, 31TDG28, 1600 m, fallen leaves of *Buxus sempervirens*, 22/IX/2002, Hoyo, BCN-Hoyo 123. LLEIDA: SALÀS DE PALLARS, BOSC DE SALÀS, 31TCG2578, 975 m, fallen leaves of *Buxus sempervirens*, 05/I/2003, Longan, BCN-Hoyo 236. COLL DEL BOIX, ALINYÀ, 31TCG66, 1280 m, dead leaves, on dead twig attached to a living plant, of *Buxus sempervirens*, 29/IX/2001, Hoyo, BCN-Hoyo 39. HUESCA: LANUZA, SALLENT DE GÁLLEGO, 30TYN2036, 1400 m, fallen leaves of *Buxus sempervirens*, 16/IX/2004, Olariaga, *BIO Fungi* 10411. Ibidem, 27/X/2004, *BIO Fungi* 10558. TARRAGONA: VILANOVA DE PRADES, PUNTA DEL CURULL, 31TCF38, 1000 m, fallen leaves of *Buxus sempervirens*, 23/X/2001, Llimona, BCN-Hoyo 41.

Typhula erythropus— FRANCE. ARDENNES, petioles of angiosperms, Montagne, UPS s.n. SPAIN. ÁLAVA: SAN ZADORNIL, 30TVN8743, 650m, petioles of angiosperm leaves, 19/X/2004, Olariaga, *BIO Fungi* 10466. GOPEGI, 30TWN2157, 600m, *Acer campestre* leaves, 2/XII/2004, Arauzo, Iglesias, Fernández, Undagoitia, Olariaga, *BIO Fungi* 10705. ÁVILA: NAVATEJERA, RÍO ARAVALLE, 30TTL8469, 1000m, *Alnus glutinosa* leaves, 9/XI/2004, Sarrionandia, Olariaga, *BIO Fungi* 10629. BIZKAIA: GETXO, MARTIARTU, 30TWN0298, 100 m, dead leaves of *Alnus glutinosa*, 22/XI/2003, Olariaga, *BIO Fungi* 1009. Idem, *BIO Fungi* 10101. BURGOS: MERINDAD DE MONTIJA, RÍO CERNEJA, 30TVN6174, 800m, dead leaves of *Corylus avellana*, 20/X/2005, Vesterholdt, Becker, Olariaga, *BIO Fungi* 11217. CÁCERES: HERVÁS, LA GARGANTA, 30TTL5963, 790m, *Alnus glutinosa* leaves, 9/XI/2004, Sarrionandia, Olariaga, *BIO Fungi* 10622. HUESCA: LANUZA, SALLENT DE GÁLLEGO, 30TYN2036, 1400m, *Populus tremula* leaves, 27/X/2004, Olariaga, *BIO Fungi* 10545. LEÓN: RIAÑO, ARROYO DE SAN PEDRO, 30TUN38, 1000m, *Acer pseudoplatanus* petioles, 1/X/2003, Olariaga, *BIO Fungi* 9919. LLEIDA: ELS BORDS, 31TCH1534, 1050m, *Populus tremula* leaves, 26/X/2004, Olariaga, *BIO Fungi* 10443. ELS BORDS, ARTIGA DE LIN, 30TCH1127, 1600m, angiosperm leaves, 26/X/2004, Olariaga, *BIO Fungi* 10546. Ibidem, leaves of *Fraxinus excelsior*, *BIO Fungi* 10550. Ibidem, *Equisetum telmateia* debris, *BIO Fungi* 10551. SWEDEN. VÄSTERGÖTLAND: Göteborg, st. ÄNGGORDEN, on decaying petioles, 14-28/IX/1943, Nathorst-Windahl, Fung. Exs. Suec. 3243 (*UPS F-05387*).

Discussion and conclusions

Typhula buxi was originally described from Vidrà (Barcelona, Spain). Maire (1933) described it as a species with a white clavula, pubescent stipe that is



Fig. 1. *Typhula buxi* (BCN-Hoyo 128). A & B: basidiomata; C: epidermoid layer; D: basidiospores. E: basidia. F: subhymenial hyphae. (Scale bars: A & B = 1 mm; C,D,E & F = 10 μ m)

dark at the base, citrine sclerotia, and basidiospores measuring $6-7 \times 3-3.5 \mu\text{m}$. *T. pallens* Maire, *T. erythropus* (Pers.) Fr. (by orthographic mistake cited as *T. erythropoda* by Maire 1933) and *T. neglecta* Pat. were regarded as related species, from which *T. buxi* could be distinguished mainly by its yellowish sclerotium

and long caulinar hairs. The collections examined for this work, including the material of the type locality, correspond with the description of the protologue. Our collections are characterized by their light clavula contrasting with the dark brown stipe, cylindrical caulinar hairs swollen at the base, amyloid basidiospores, as well as the habitat on dead leaves of *Buxus sempervirens*, as described by Maire (1933).

Table 1. Length, width and Q of selected material of *T. buxi*.

Collection	Length (µm)	Width (µm)	Q
Protologue (Maire 1933)	6-7	3-3.5	--
BCN-Hoyo 39	(7-)7.5-8.5(-9)	(3-)4-5	1.90
BCN-Hoyo 40	(7.5-)8.5-9.5(-10)	3-5	2.20
BCN-Hoyo 123	7-9(-9.5)	(3-)3-3.5	2.48
BCN-Hoyo 128	(7-)7.5-9(-9)	3-4(-5)	2.21
BCN-Hoyo 179	7-8	3-4(-4.5)	2.18

Slight differences, however, can be noticed. Firstly, the basidia and basidiospores measurements given by Maire (1933) are slightly smaller. On the one hand, a rather high variability was observed in our material, both in length and shape (Table 1). On the other hand, KOH was used to rehydrate our material, which is known to swell the structures. Conversely, the measurements of Maire were probably not taken in the same medium. Those phenomena might thus explain the differences found. Secondly, according to our observations, the colour of the sclerotia can vary from pale brown to dark brown. Although this characteristic does not exactly coincide with the protologue, the colour observed in part of the examined material is noticeably lighter than in most of *Typhula* species. The shape of the sclerotium is also variable, as Maire pointed out.

On the basis of all these observations, we consider that the examined material undoubtedly belongs to *T. buxi*. Furthermore, this view is supported by examinations of material from the type location. Berthier (1976) included *T. buxi* in the subgenus *Cnazonaria* (characterized by possessing an inverse epidermoid layer) but did not explain why he did so. Berthier was not able to verify the structure of the sclerotium because no original material of *T. buxi* was known (Berthier 1976) and the description of Maire (1933) was prior to the development of the knowledge of the sclerotial structure (Remsburg 1940, Berthier 1974, 1976). After examining our material, it is clear that *T. buxi* belongs instead to the subgenus *Microtyphula*, since it has a normal epidermoid layer without cutis.

As noted above, Maire (1933) cited *T. erythropus* as a species related to *T. buxi*. *T. erythropus* is a very well-known species that has been described and

illustrated in several works (Corner 1950; Koske 1974, 1975; Berthier 1976; Maas Gesteranus 1976; Breitenbach & Kranzlin 1986). Some characteristics are shared by both species, such as the slender basidiomata that are longer than in other *Typhula* species, a dark lower stipe, amyloid basidiospores, and a normal epidermoid layer without cutis. This last character is the reason why both species are ascribed to the subgenus *Microtyphula*. Furthermore, the epidermoid layer of both species is composed of cells with characteristic sinuous or undulate outline. The differences between the two species are summarised in Table 2.

Table 2. Distinctive characteristics between *T. buxi* and *T. erythropus*. The colours have been noted from fresh material

	<i>T. buxi</i>	<i>T. erythropus</i>
Caulinar hairs	Cylindrical, sinuous, with widened base	Conical, septate
Clavula	Greyish white, yellowish grey, pale ochre	White
Sclerotium	Pale brown, ochre, dark brown	Dark brown, blackish brown
Habitat	Dead leaves of <i>Buxus sempervirens</i>	Dead leaves of various hardwoods: <i>Acer</i> , <i>Alnus</i> , <i>Corylus</i> , <i>Fraxinus</i> ,... Rarely other substrata
Basidiospores (X)	7-9 × 3-5 µm	5.5-8 × 2-4 µm

The substrates of *T. erythropus* and *T. buxi* seem to be different. While most sclerotia of *T. erythropus* are found on petioles, those of *T. buxi* are usually found on limbs. The oblong form of the sclerotia of *T. erythropus* might be an adaptation to growing on petioles, which has not been observed in the examined material of *T. buxi*. Conversely, more rounded sclerotia are found in *T. buxi*, as they develop on limbs. Basidiospore sizes sometimes overlap in both species, but the basidiospores of *T. erythropus* are often smaller than those of *T. buxi*.

No type was designated for *Typhula buxi* by Maire (1933) in his original description. Furthermore, the type specimens could not be located in any of the five herbaria where Maire's collections are curated (Stafleu & Cowan 1981, Holmgren & Holmgren 1998): PC (B. Duhem, pers. comm.), MPU (no response after repeated requests; Berthier's 1976 note, "*pas de specimens conservés dans l'herbier Maire*"), G (P. Clerc, pers. comm.), NCY (R. Pierrel, pers. comm.), and AL (no response after repeated requests).

Therefore, in accordance with Art. 9.2 of the International Botanical Code of Nomenclature (McNeill et al. 2006), we propose as lectotype Figure 4 in Maire

(1933), which is another element cited by the author in the protologue. As the sclerotial structure of *T. buxi* can neither be inferred from the protologue nor verified from any original collection, in accordance with Art. 9.7 of the Code (McNeill et al. 2006), we designate an epitype in order to interpret the protologue correctly and verify the taxonomic position of the species. A specimen from the type locality has been selected as epitype.

Acknowledgements

We feel very indebted to Svengunnar Ryman, who guided us through the typification of *T. buxi*. We also thank Luis Alberto Parra for giving us useful nomenclatural advices. We express our gratitude to Ireneia Melo and Jack D. Rogers for reviewing the manuscript of this article, as well as to B. Duhem (PC), P. Clerc (G) and R. Pierrel (NCY) who gently provided us information about the *T. buxi* collections. This work has been partially supported by a “grant for the Formation of Researchers of the Basque Government (2002/2003)” and by the Dept. d’Universitats Recerca i Societat de la Informació (2005SGR01047 Catalan Government).

Literature cited

- Berthier J. 1974. Le genre *Typhula* (Clavariacées) et les genres affines. Classification. Espèces nouvelles Bull. Mens. Soc. Linn. Lyon 43(6): 182-188.
- Berthier J. 1976. Monographie des *Typhula* Fr., *Pistillaria* Fr. et genres voisins. Numéro special. Bull. Mens. Soc. Linn. Lyon 45.
- Breitenbach J, Kranzlin F. 1986. Champignons de Suisse. N° 2. Ed. Mykologia. Lucerne.
- Corner E.J.H. 1950. A Monograph of *Clavaria* and allied genera. Oxford University Press. London.
- Fries E. 1818. Observationes Mycologicae praecipue ad illustrandam floram Suecicam. Pars II, Hauniae.
- Fries E. 1821. Systema mycologicum. I. Lund. Berlin. 520 p.
- Holmgren PK, Holmgren NH. 1998 onwards (continuously updated). Index Herbariorum. New York Botanical Garden. [<http://sciweb.nybg.org/science2/IndexHerbariorum.asp>. (viewed online on 9 January 2007)].
- Hoyo P, Gómez-Bolea A. 2003. Contribución a los hongos que viven sobre *Buxus sempervirens*. XIV Symposium of Cryptogamic Botany. Murcia.
- Jülich W. 1984. Die Nichtblätterpilze, Gallerpilze und Bauchpilze Kleine. Kryptogamenflora Band II. Gustav Fischer Verlag. Stuttgart. 597 p.
- Karsten PA. 1882. Rysslands, Finlands och den Skandinaviska halföns Hattsvampar. Sednare Delen: Pip-, Tagg-, Hud-, Klubb- och Gelésvampar. Bidrag till Kännedom af Finlands Natur och Folk 37. 257 p.
- Koske RE. 1974. *Typhula erythropus*: Field history, germination of basidiospores, mycelial growth, and sclerotial formation. Mycologia 66: 298-318.
- Koske RE. 1975. *Typhula erythropus*: II. Sclerotial germination and basidiocarp production. Mycologia 67: 128-146.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th ed. CABI Publishing, Egham. 655 p.

- Maas Gesteranus RA. 1976. De fungi van Nederland de Clavarioide Fungi (*Auriscalpiaceae*, *Clavariaceae*, *Clavulinaceae*, *Gomphaceae*). Wetensch. Meded. Kon. Ned. Natuurhist. Ver. 113: 1-92.
- Maire R. 1933. Fungi Catalaunici. Contributions à l'étude mycologique de la Catalogne. Treb. Mus. Cien. Nat. Barcelona 15 (2): 1-120.
- Malençon G, Bertault, R. 1968. Champignons du Maroc. Bull. Soc. Sci. Nat. Maroc 47 (3-4): 237-281. (1967).
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Regnum Vegetabile 146. 568 p.
- Munsell® 1994. Soil Color Charts. New York: Macbeth Division of Kollmorgen Instruments Corporation.
- Persoon CH. 1801. Synopsis fungorum. Göttingen. 706 p.
- Pilát A. 1958. Přehled hub kyjankovitých-Clavariaceae se zvláštním zřetelem k československým druhům. Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 14 (3-4): 129-255.
- Remsberg RE. 1940. Studies in the genus *Typhula*. Mycologia 32: 52-96.
- Stafleu FA, Cowan RS. 1981. Taxonomic literature. Volume III: Lh-O. Bohn, Scheltema & Holkema. Utrecht.

***Cyathicula brunneospora* and *Pirottaea atrofusca*, two new *Helotiales* from Tian Shan (Kazakhstan)**

MARKÉTA CHLEBICKÁ¹ & ANDRZEJ CHLEBICKI^{2*}

marketa_chlebicka@nm.cz

¹Mycological Department, National Museum

Václavské nám. 68, CZ-115 79 Praha 1, Czech Republic

*ibchlebick@ib-pan.krakow.pl

²Polish Academy of Sciences, W. Szafer Institute of Botany

Lubicz 46, PL-31-512 Kraków, Poland

Abstract—Two new species from Tian Shan are described: *Cyathicula brunneospora* on *Anthoxanthum alpinum* and *Carex griffithii* and *Pirottaea atrofusca* on *Festuca coelestis*. New combinations *Cyathicula melanospora* and *Cyathicula* sect. *Scelobelonium* are proposed.

Key words—discomycete, taxonomy, graminicolous fungi, caricicolous fungi

Introduction

Ascomycete fungi of the western part of Tian Shan have been described only sporadically. Schwartzman (1962) listed fungi from such genera as *Cenangium* Fr., *Erysiphe* R. Hedw. ex DC., *Geoglossum* Pers., *Gyromitra* Fr., *Helvella* L., *Lophodermium* Chevall., *Mitrulella* Fr., *Morchella* Dill. ex Pers., *Naemacocyclus* Fuckel, *Otidea* (Pers.) Bonord., *Phyllactinia* Lév., *Podosphaera* Kunze, *Rhytisma* Fr., *Sarcoscypha* (Fr.) Boud., *Sphaerotheca* Lév., *Terfezia* (Tul. & C. Tul.) Tul. & C. Tul., *Uncinula* Lév., and *Venturia* Sacc. Among the hyaloscyphaceous fungi from Tian Shan cited by Raitviir (2004) are *Cistella tianschanica* Raitv. and *Hyalopeziza tianschanica* Raitv. In 2005 we collected fungi from the upper limits of where plants grow in Central Tian Shan. We noted mostly saprotrophic and parasitic species, including *Cainia graminis* (Niessl) Arx & E. Müll., *Lophodermium alpinum* Rehm, *Lachnellula arida* (W. Phillips) Dennis, *Comoclathris planispora* (Ellis) Harr, *Wettsteinina oreophila* Shoemaker & C.E. Babcock, and others. Amongst our materials we also found new and very rare species belonging to basidiomycete and ascomycete groups. In this article we describe two new species, which belong to *Helotiales*.

Methods

Dried material was examined, measured and prepared under a zoom stereo microscope (Nikon SMZ 1500, Olympus SZ 61), and also with a light microscope (LM) Olympus BX-51 equipped with an oil immersion lens, at magnifications of 1000x and 2000x (using a magnification changer), and in some cases using Nomarski contrast (DIC). Line drawings were produced using a drawing tube. Microscopical observations and measurements are based on herbarium material prepared in 3% KOH unless otherwise indicated. Freehand-made longitudinal sections of apothecia were observed in water or 3% KOH. Lugol's solution (IKI: 1% iodine, 3% KI in water), Melzer's reagent (MLZ), and 5% KOH were used to describe the reactions of apical rings and character of setae for *Pirottaea*. Gelatinous sheaths of free ascospores were observed in India ink. Materials are deposited at the National Museum in Prague (Czech Republic) and the W. Szafer Institute of Botany of Polish Academy of Sciences in Kraków (Poland).

Cyathicula brunneospora M. Chleb. & Chleb., sp. nov.

FIGURES 1-3

MYCOBANK MB 510547

Diagnosis: A specie *Belonidium melanosporum* Rehm ascis inamyloideis, sporis permanentemente brunneis atque laevibus, absentia strato excipuli ex cellulis magnis prismaticis biserialiter ordinatis discrepat.

Etymology: The specific epithet refers to the brown ascospores.

SPECIMENS EXAMINED: KAZAKHSTAN, TIAN SHAN: Zailijskij Alatau Mts., VALLEY OF ISSYK (YSSYK) RIVER, UPSTREAM FROM THE POINT WHERE ISSYK DIVIDES INTO TWO BROOKS, AT THE MORaine OF THE SOUTH BROOK, N 43° 07' 45", E 77° 30' 32", 3490 m elev., on fallen dead culms of *Anthoxanthum alpinum* Á. Löve & D. Löve, 7 August 2005, coll.: M. Suková (Chlebická), **HOLOTYPE**—PRM 907424. TIAN SHAN: Zailijskij Alatau Mts., ISSYK VALLEY, N 43° 07' 52.5", E 77° 30' 25", 3445.5 m elev., on *Carex griffithii* Boott, 3 August 2005, coll.: A. Chlebicki, **PARATYPES:** KRAM "F": 55679, 55680, 55681, 55682, 55683.

Description: **Apothecia** cupulate, 0.2-0.7 mm high, 0.3-1.1 mm in diam. when dry, shortly stipitate, margin non dentate, receptacle olive brown or dark blackish brown, covered with pale powder at margin and less densely at flanks, stalk pale brown or dark brown, disc dark olive-brown or dark brown, mature apothecia open when moist and staying open or becoming closed on drying. **Excipulum:** Outer layer of ectal excipulum dark brown, inner layer and medulla hyaline, hymenium dark brown. The ectal excipulum composed of parallel hyphae in a gelatinous matter, oriented at a low angle or almost parallel to the surface (textura oblita). Rhomboid crystals on the outer surface of the apothecium present (observed in water). The medullary excipulum composed of freely intertwined hyphae (textura intricata). **Asci** 113-119 x 13.5-16 µm, cylindric-clavate, non-stipitate or rarely very shortly stipitate, arising from croziers, 8-spored, with biserial ascospores, apical ring without any reaction in MLZ,

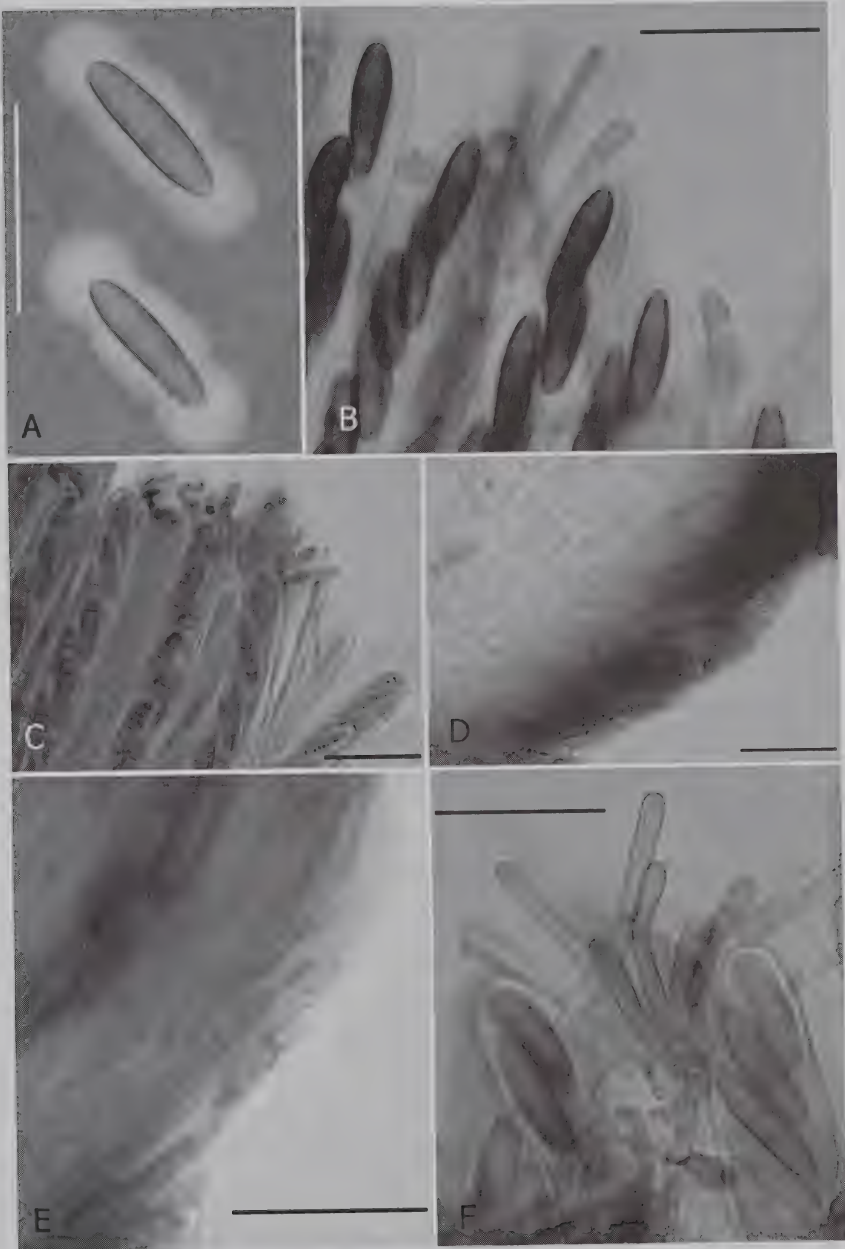


Fig. 1. *Cyathicula brunneospora*: A: ascospores with gelatinous sheaths (India ink); B: ascus apices (5% KOH/MLZ); C: hymenium (5% KOH/IKI); D: ectal excipulum and medulla (water); E: ectal excipulum (water); F: paraphyses and asci (water).
Scale bars A-F: 30 μm.

KOH/MLZ, IKI, KOH/IKI. **Ascospores** elliptic-fusoid, pale brown when young, dark brown when mature (brown when observed in water), always smooth, 3-septate, very rarely up to 7-septate, 23-29.5 x 5.9-7.2 μm , surrounded by a hyaline, gelatinous sheath, which is constricted at the end spore cells, 5.8-8.6 μm thick at spore ends and 3.5-5.3 μm thick at the middle spore septum. **Paraphyses** cylindric-clavate, hyaline and septate in their lower parts (1.9-2.6 μm broad), branched and septate in their upper parts, with enlarged, 3.8-4.5 μm broad, smooth, pale brown tips (Figs. 1-3).

Comments—*Cyathicula brunneospora* is close to *Cyathicula melanospora* (syn. *Crocicreas melanosporum*). The latter occurs in arctic and alpine habitats on culms of *Poaceae*, stems of *Juncaceae* and dicotyledonous herbs and is known from Finland, Switzerland, Austria and USA (Carpenter 1981, Müller 1977, Rehm 1893, Vesterholt 2000). *Cyathicula brunneospora* is known only from the vicinity of the type locality (Asia, Kazakhstan); however, it is possible that other Asian material of the species may be deposited in herbaria currently identified as *Crocicreas melanosporum*. Ascospores of *Cyathicula melanospora* are hyaline when young (Rehm 1882, Carpenter 1981) and roughened in maturity (Carpenter 1981). In *Cyathicula brunneospora* we observed that ascospores are permanently smooth and early becoming pale brownish in youth. The main difference is in the amyloidity of the ascoapical ring, which in *C. brunneospora* is unreactive in MLZ and IKI (with or without KOH pretreatment) but in *C. melanospora* is light blue in MLZ (Carpenter 1981) and violet in IKI (Rehm 1882, Rehm 1893: 747). In contrast to *C. melanospora* of Carpenter's description and drawing, in *C. brunneospora* the excipulum lacks the thin layer with two rows of big prismatic cells. Such a layer is present on the flanks and at the margin of the excipulum in *C. melanospora*. Mature apothecia are cup-shaped in *C. brunneospora* while Carpenter (1981) describes the apothecia of *C. melanospora* as remaining closed (unopened) in maturity, citing 15 collections including the type collection. The difference in apothecial opening between *C. brunneospora* and *C. melanospora*, however, become irrelevant, when checking Rehm. Rehm (1882) originally described the apothecia of *C. melanospora* as "perithecia" urceolate-turbinate and later (Rehm 1893) reported on the same collection that apothecia are at first closed and then opening.

In agreement with Baral (2005), we accept that *Crocicreas* Fr. (type species *C. gramineum* (Fr.) Fr.) is not congeneric with *Cyathicula* De Not. (type species *C. coronata* (Bull.) De Not. ex P. Karst.). Paraphyses of *Crocicreas gramineum* are of two intergrading morphologies, lanceolate and cylindrical (Carpenter 1981), while paraphyses of *Cyathicula* are cylindrical to clavate. Further differences between the two genera include the shape of the ascus apical ring (Triebl & Baral 1996), which is, however, not well described in *C. melanospora* and non-

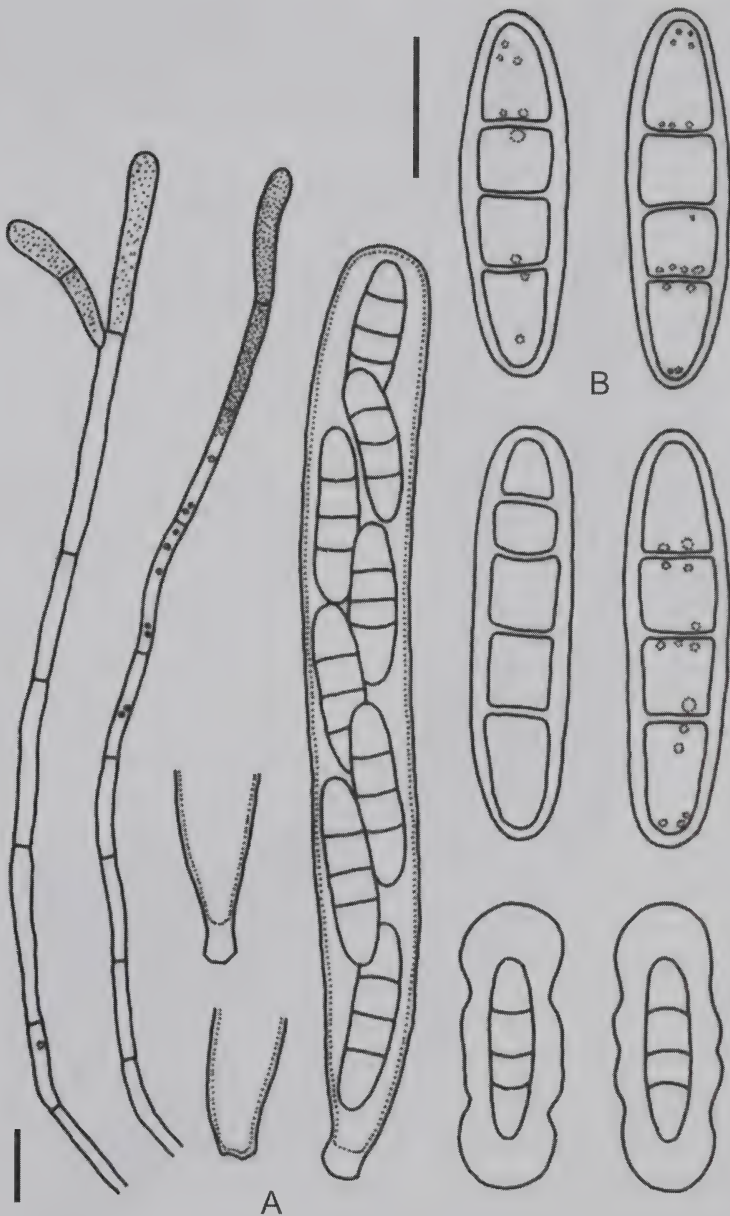


Fig. 2. *Cyathicula brunneospora*: A: paraphyses, bases of asci, ascus (3% KOH) and ascospores with gelatinous sheaths (India ink); B: ascospores (3% KOH). Scale bars A-B: 10 μm.

Note: Brown colour of ascospores is not depicted in these drawings.

amyloid in *C. brunneospora*. According to Svrček (1979), species of *Cyathicula* with apothecia without marginal dents should be placed in a separate genus, *Conchatium* Velen. We do not accept Svrček's opinion and place our new species together with *C. melanospora* (both with non-dentate apothecia) into the genus *Cyathicula*.

***Cyathicula melanospora* (Rehm) M. Chleb. & Chleb., comb. nov.**

MYCOBANK MB 510549

Basionym: *Belonidium melanosporum* Rehm, Hedwigia 21: 100, 1882.

≡ *Belonium melanosporum* (Rehm) Sacc., Sylloge Fungorum 8: 496, 1889.

≡ *Belonioscypha melanospora* (Rehm) Rehm, Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 2. Ed., 1(3): 746, 1893.

≡ *Scelobelonium melanosporum* (Rehm) Höhn., Annalen des K.K. Naturhistorischen Hofmuseums Wien 20: 367, 1905.

≡ *Crocicreas melanosporum* (Rehm) S.E. Carp., Brittonia 32: 270, 1980.

In our opinion, *Cyathicula culmicola* (Desm.) S.E. Carp. & Dumont, *C. melanospora*, and *C. brunneospora* form a separate group within the genus *Cyathicula* based on their characteristic ascospores (relatively thick-walled and with a gelatinous sheath) and also apically enlarged, at least rarely branched paraphyses. The members of this group occur from colline (e.g. Velenovský's material of *C. culmicola* from the vicinity of Mnichovice examined by Carpenter 1981: 60, specimens PRM 150416, 150417 and 150467) to alpine altitudes and are known from grass culms, stems of *Juncaceae* and *Cyperaceae*, and several dicotyledonous plants. We would prefer to separate this group as a section of *Cyathicula*. To separate the group at generic level, it should need molecular taxonomic methods. The name *Belonioscyphae* (derived from Rehm's *Belonioscypha*) would be appropriate for this section from a taxonomical point of view. We agree with Stadelmann (1978) and Carpenter & Dumont (1978) and accept *Belonioscypha culmicola* (Desm.) Dennis as the lectotype species of the genus. Von Höhnelt (1918) and Nannfeldt (1932) considered another species—*Belonioscypha campanula* (Nees) Rehm—as the lectotype ("die Grundart", pseudotypus), however, this lectotypification is based on mechanical method of selection (Art. 10.5.b. of the Vienna Code). The characters sketched in the original generic description of *Belonioscypha* by Rehm (1893) generally agree with our conception of the section, with these few differences: we here include only species with ascospores enclosed by gelatinous sheath, species with as well as without reaction of ascoapical ring in IKI and species with hyaline as well as brown paraphyses. According to Stadelmann (1978), two additional species (*Belonioscypha miniata* Kanouse and *B. alpina* Stadelmann) with ascospores sometimes encased in gelatinous sheaths might possibly belong to the section, but we cannot judge the character of the ascospore wall from Stadelmann's drawings.



Fig. 3. *Cyathicula brunneospora*: Excipulum in longitudinal section (3% KOH). Scale bar: 50 μ m.

Saccardo (1889) had another concept: he considered the colour of the apothecia as a defining character. On this basis he distinguished between *Belonium* Sacc. (species with black or brown apothecia) and *Belonidium* Mont. et Durieu (species with apothecia of pale colours). Representatives of Rehm's genus *Belonioscypha* belonged in Saccardo's work to *Belonium* sect. *Scelobelonium* Sacc. and *Belonidium* sect. *Podobelonium* Sacc. Saccardo created these two sections for those species of each genus with stalked apothecia.

Section *Scelobelonium* (Saccardo 1889) originally contained only *Belonium melanosporum* (Rehm) Sacc., one of the species of our proposed section within *Cyathicula*. *Belonioscypha* has priority over *Scelobelonium* at generic rank, but the latter has priority at the rank of section. We therefore retain the name *Scelobelonium* for our proposed section, although this involves far greater emendation than would be required for a section based on *Belonioscypha*. We include in the section also a species with pale-coloured apothecia, *Cyathicula culmicola*, which Saccardo placed under *Belonidium* sect. *Podobelonium* as *B. vexatum* De Not.

No lectotype was probably proposed for *Podobelonium* (Sacc.) Sacc. & D. Sacc. until Carpenter (1981) designated *Peziza campanula* Nees. As we agree with Dennis (1956: 40) and Cooke (1961) that *Peziza campanula* (*Calyprella campanula* (Nees) W.B. Cooke) represents a basidiomycete, the name *Podobelonium* has no relevance to our section.

***Cyathicula* sect. *Scelobelonium* (Sacc.) M. Chleb. & Chleb., comb. nov.**

MYCOBANK MB 510550

Basionym: *Belonium* sect. *Scelobelonium* Sacc., Sylloge Fungorum 8: 496, 1889.

≡ *Scelobelonium* (Sacc.) Höhn., Annalen des K.K. Naturhistorischen Hofmuseums Wien 20: 367, 1905.

Type species: *Belonium melanosporum* (Rehm) Sacc.

Syn.: *Belonioscypha* Rehm, Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 2. Ed., 1(3): 743, 1893. – Type species: *B. vexata* (De Not.) Rehm [= *B. culmicola* (Desm.) Dennis fide Saccardo (1889: 503), Dennis (1956: 39)], lectotype designated by Clements & Shear (1931).

Our delimitation of the section: Apothecia white, pale-coloured to blackish-brown, ascospores hyaline to brown, (septate), relatively thick-walled and with gelatinous sheath, paraphyses hyaline to brown, apically enlarged, at least rarely branched. We include in the section *Cyathicula culmicola*, *C. melanospora* and *C. brunneospora*.

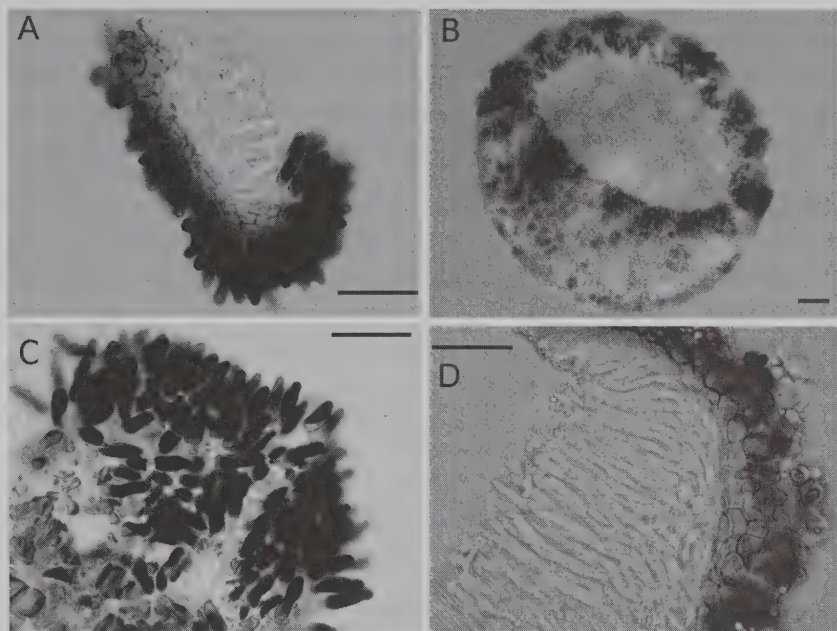


Fig. 4. A-C: *Pirottaea atrofusca*: A: excipulum in longitudinal section (3% KOH); B: apothecium rehydrated in water; C: setae on outer surface of apothecium (3% KOH); D: *Pirottaea* cf. *imbricata* PRM 877304: excipulum in longitudinal section (3% KOH). Scale bars A-D: 20 μ m.

***Pirottaea atrofusca* Chleb. & M. Chleb., sp. nov.**

MYCOBANK MB 510375

FIGURES 4, 5

Diagnosis: Apotheciis minutis 50-180 μ m diam., *Pirottaeae imbricatae* similis sed differt setis spathulatiformibus vel navicularibus, minoribus 4-13.5 x 4-4.5(-5) μ m, non-septatis et sporiis longioribus (8)9-11 x 1.5-2.2 μ m, atque habitatione in *Festuca coelestis*.

Etymology: The specific epithet refers to the distinctly brown-black apothecia.

SPECIMENS EXAMINED: KAZAKHSTAN, TIAN SHAN: Zailiyskij Alatau Mts., VALLEY OF ISSYK (YSSYK) RIVER, N 43° 07' 52.5", E 77° 30' 25", 3445.5 m elev., on leaves of *Festuca coelestis* (St.-Yves) Krecz. & Bobr., 3 August 2005, coll.: A. Chlebicki, **HOLOTYPE**-KRAM "F" 55672.

Description: Apothecia cup-shaped, sessile or rarely very shortly stalked, (50-) 60-120 μ m in diam. when dry, rehydrated up to 180 μ m diam., 40-60 μ m high, dark brown to nearly black, disc cream-white to pale brown. Setae densely distributed in upper part of apothecium (Fig. 4), arranged into short irregular streaks narrowing toward the base, brown in water, dark brown in 5% KOH, reddish brown in MLZ after 5% KOH, main part of seta dark brown, basal part distinctly paler (Figs. 4, 5), $\pm$ spathulate to naviculate (wider in the upper

part) with slightly tapered or hemispherical head, solid part 4-13.5 x 4-4.5(-5) μm , with refractive wall, matrix not losing refractiveness in 5% KOH, lumen restricted to base. **Grana** sparse to abundant, especially below streaks of the setae, dark and thick-walled. **Ectal excipulum** textura angularis, cells pale brown. **Asci** arising from croziers, $\pm$ cylindric-clavate, 8-spored, narrower in the upper part (32-)38-42 x 4.5-5.2 μm (dead state in water), IKI+ pale blue, KOH/MLZ+ blue. **Ascospores** aseptate, hyaline, narrowly fusoid, (8-)9-11 x 1.5-2.2 μm (dead state in water), with two oil drops (in 3% KOH), irregularly biseriate in dead asci. **Paraphyses** filiform, up to 1.2 μm broad, not exceeding the asci, 0-1 septate in lower part (Fig. 5).

Comments—The ectal excipulum of this fungus is composed of textura angularis whereas in the similar genus *Venturiocistella* Raitv. (*Hyaloscyphaceae*) it is composed of textura angularis-prismatica (Raitviir 2004). However, a graminicolous species, *V. heterotricha* (Graddon) Baral possesses ectal excipulum composed of brownish textura globulosa characteristic to the *Dermateaceae* and belongs to an undescribed genus of the *Dermateaceae* (Raitviir 2004). Also Baral (2005) noted some differences between *V. heterotricha* and *Venturiocistella* s. str., such as smooth hairs and setae, and thick hyaline to pale brown wall of spores. The textura of our fungus is characteristic to the *Dermateaceae*. The presence of hairs or setae is also known from some *Dermateaceae*; therefore, we place the fungus into this family. Our specimen is very similar to *Pirottaea imbricata* Nannf. This species possesses mostly non-septate setae with obtuse ends. Nannfeldt (1985) pointed out that the apothecial margin of *P. imbricata* is bordered by short setae evolved from lateral hairs. Such origin of the setae can indicate connection with the genus *Pyrenopeziza* Fuckel. Apothecia of the genus *Pyrenopeziza* sensu Hütter (1958) are covered by marginal hairs (Müller 1989) and very rarely by protuberances called ‘grana’ (“Excipulumauswüchse”), or are devoid of any hairs, whereas lateral setae and grana are commonly found in *Pirottaea*. Setae can be considered as structures delimited with distinct, thick septa, which separate them from the ectal excipulum (Nannfeldt 1985, Müller 1989, Nauta & Spooner 2000). Lateral hairs are hypha-like, mostly hyaline or pale brown structures originated from grana or pale-walled excipular cells (Nannfeldt 1985) as in *Pyrenopeziza millegrana* Boud. The ‘hair’ structures of our specimen and specimen H.B. 4922a (cited below) can therefore be named true setae, sensu Nannfeldt. Hence we place the new species into the genus *Pirottaea*.

There are 52 described species of *Pirottaea* in Index Fungorum. Baral (2005) illustrated some specimens he tentatively referred to *P. imbricata*. Especially his drawing no. H.B. 4922a, illustrating a specimen collected by Karl Helm on *Laserpitium latifolium* L. in Austria, possesses setae very similar to the setae of our fungus. Setae of both fungi have the same width from base to apex, and

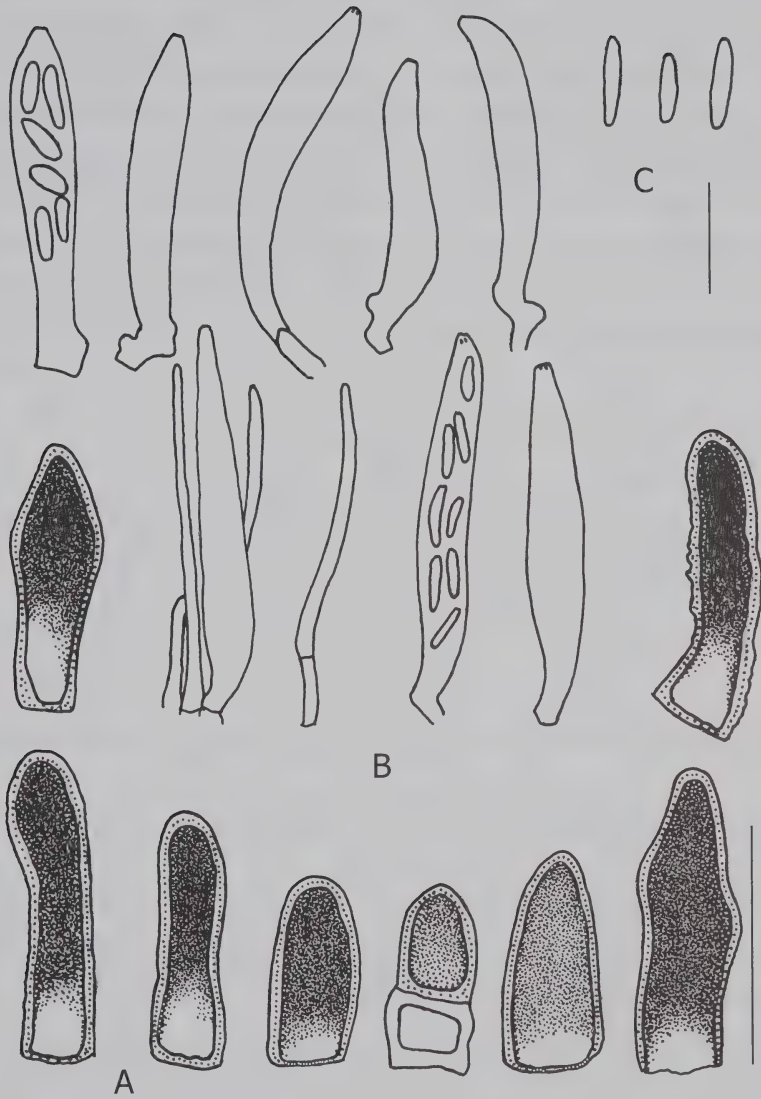


Fig. 5. *Pirottaea atrofusca*: A: setae (3% KOH); B: asci and paraphyses (water); C: ascospores (water). Scale bars A-C: 10 μ m.

their upper part is solid while the lumen is restricted to the lower 1/2-1/4 of the setae. There are also some differences. The specimen from *Laserpitium* has slightly longer (9-21 x 3.5-5.3 µm), light to medium yellowish-brown setae and distinctly bigger apothecia (450 µm diam.). Another specimen (H.B. 7551a, on *Leycesteria formosa* Wall., leg. E. Batten, from England) possesses septate setae with dark brown walls which are solid along one lateral face, not at the apex, and are arranged in more regular streaks and abundant grana. The setae of *P. imbricata* (Nannfeldt 1985) are cylindrical, with hemispherical tips, and are strongly constricted at the septa while an internal solidification is not mentioned. The setae of *P. atrofusca* are spathulate or naviculate with slightly tapered heads (see Tab 1). According to Nannfeldt (1985) and Holm & Nannfeldt (1992) a specimen published as '*P. imbricata*' on *Valeriana* spp. proved to be an independent taxon. It is possible that each of the taxa presented in Tab. 1 belongs to a separate species.

Table 1. Comparison of selected characters of *Pirottaea atrofusca* and *P. imbricata*

Characters	<i>P. atrofusca</i> This article	<i>P. imbricata</i> Nannfeldt (1985)	<i>P. imbricata</i> Baral (2005) HB 4922a	<i>P. imbricata</i> PRM 877304
Diam. of apothecia (µm)	Dry: (50)60-120 rehydrated: 180	Dry: 100-150	Fresh: up to 450	Dry: 100-160 rehydrated: 160
Setae (µm)	Non-septate, 4-13x4-4.5(5), spathulate or naviculate with slightly tapered head	Mostly non-septate, 6-15x3(4), cylindrical with hemispherical head	Non-septate, 9-21x3.5-5.3 cylindrical to naviculate with slightly tapered head	0-2-septate, 9.6-16x(3.1)4- 4.8 cylindrical to clavate with rounded head
Ascus size (µm)	(32)38-42x4.5-5.2	30-40x4	39-51(57)x6-7.5	36-42x3.7-4.6
Spore size (µm)	(8)9-11x1.5-2.2	6-8x1-1.5	(6)7.5-10x2-2.2	7.3-9(10)x1.8-2
Paraphyses (µm)	1.2 wide, 0-1 septate	No information	1.7-2.3 wide, 1-septate	1.5-2.4 wide, 1-3 septate
Host	<i>Festuca coelestis</i>	<i>Cirsium oleraceum</i>	<i>Laserpitium latifolium</i>	<i>Valeriana sambucifolia</i>

Nannfeldt (1985) considered it difficult to draw precise limits between the genera *Pyrenopeziza* and *Pirottaea* because the large genus *Pyrenopeziza* is insufficiently investigated. It is also difficult to provide a clear distinction between the *Pirottaea imbricata* group and other lineages of the genus

Pirottaea. According to Nannfeldt (1985) there are four independent lineages within *Pirottaea*, each of which can be connected to hypothetical ancestors of *Pyrenopeziza* species. The *P. imbricata* group to which our species belongs, has been placed in his fourth lineage. Nannfeldt pointed out that the “crucial features of this lineage are the thick wall of the setae (including basal septum) and the “double” septa between all or most cells in septate setae”. *P. atrofusca* possesses mostly non-septate setae, whereas the true *P. imbricata* and specimen H.B. 7551a have both non-septate and septate setae. There are also transitional species such as *P. geraniicola* Nannf., *P. paupercula* Nannf. and *P. trichostoma* (Kirschst.) E. Müll. & Arx, which possess distinctly septate marginal setae. Nannfeldt (1985) suggested that fungi from the genus *Pirottaea* are host specialized with narrow host-spectra. Members of the *P. imbricata* group inhabit *Laserpitium latifolium* (Baral 2005), *Cirsium oleraceum* Scop., *Valeriana sambucifolia* Eichw., *Cynanchum vincetoxicum* Pers. (Nannfeldt 1985) and *Festuca coelestis* (this article).

Acknowledgements

We thank Hans Otto Baral and Ricardo Galán Márquez for valuable comments on our manuscript. Dr. Mirko Svrček kindly helped us with the Latin. Anna Pringle and Jeanette Fink gave us assistance with English. Financial support provided by Project No. 2 P04F 066 28, awarded by the Ministry of Science and Information Society Technologies, Poland, and a grant of the Ministry of Culture of the Czech Republic no. MK00002327201 is gratefully acknowledged.

Literature cited

- Baral HO. 2005. In vivo veritas. Ed. 3. Manuscripts including macro- and micrographs distributed by the author on DVD.
- Carpenter SE. 1981. Monograph of *Crocicreas*. Mem. New York Bot. Gard. 33: 1–290.
- Carpenter SE, Dumont KP. 1978. *Leotiaceae* I. Nannfeldt's *Phialeoideae*: The genera *Belonioscypha*, *Cyathicula* and *Phialea*. Mycologia 70: 1223–1238.
- Clements FE, Shear CL. 1931. The genera of fungi. H.W. Wilson & Co.: New York. 496 pp. 58 tabs.
- Cooke WB. 1961. The cyphellaceous fungi. A study in the *Porotheliaceae*. Sydowia, Beih. 4: 1–144.
- Dennis RWG. 1956. A revision of the British *Helotiaceae* in the herbarium of the Royal botanic gardens, Kew, with notes on related European species. Mycol. Pap. 62: 1–216.
- Holm L, Nannfeldt JA. 1992. Fungi Exsiccati Suecici, praesertim Upsalienses, fascicle 69. Thunbergia 16: 1–22.
- Höhnelt Fv. 1918. Fragmente zur Mykologie (XXII. Mitteilung Nr. 1092–1153). Sitzungsber. Akad. Wiss. Wien, Math.-Naturwiss. Kl., Abt. 1, 127: 549–634.
- Hütter R. 1958. Untersuchungen über die Gattung *Pyrenopeziza* Fuck. Phytopathol. Z. 33: 1–54.
- Müller E. 1977. Zur Pilzflora des Aletschwaldreservats (Kt. Wallis, Schweiz), in: Beiträge zur Krypt. Fl. Schweiz, 15(1): 1–126.
- Müller E. 1989. Two new and unusual mollisioid discomycetes. Mem. New York Bot. Gard. 49: 311–314.

- Nannfeldt JA. 1932. Studie über der Morphologie und Systematik der nichtlichenisierten und inoperculaten Discomyceten. Nova Acta Reg. Soc. Sci. Upsal., ser. 4., 8: 1–368.
- Nannfeldt JA. 1985. *Pirottaea* (Discomycetes Inoperculati), a critical review. Symbolae Botanicae Upsalienses 25: 1–41.
- Nauta MM, Spooner B. 2000. British *Dermataceae*: 4B. *Dermateoideae* genera G–Z. Mycologist 14: 65–74.
- Raitviir A. 2004. Revised synopsis of the *Hyaloscyphaceae*. Scripta Mycologica 20: 1–133.
- Rehm H. 1882. Beiträge zur Ascomyceten-Flora der deutschen Alpen und Voralpen. Hedwigia 21: 97–103.
- Rehm H. 1893. Ascomyceten: Hysteriaceen und Discomyceten. Lf. 39. in Rabenhorst's Krypt.-Fl. Deutschl., Oest. und Schweiz, 2. Ed., 1(3): 721–784.
- Saccardo PA. 1889. Sylloge Fungorum. 8. Saccardo: Patavii. 1143 pp.
- Schwartzman SR. 1962. Materialy k istorii mikoflory Kazakhstana. Izdatelstvo Akademii Nauk Kazakhskoj SSR: Alma-Ata. 369 pp.
- Stadelmann RJ. 1978. Beitrag zur Kenntnis der Discomyceten-Gattung *Belonioscypha* Rehm. Nova Hedwigia 30: 815–833.
- Svrček M. 1979. New or less known Discomycetes. X. Česká Mykol. 33: 193–206.
- Triebel D, Baral HO. 1996. Notes on the ascus types in *Crocicreas* (*Leotiales*, *Ascomycetes*) with a characterization of selected taxa. Sendtnera 3: 199–218.
- Vesterholt J. 2000. *Crocicreas* Fr. 141–145, in L. Hansen, H. Knudsen (eds.), Nordic macromycetes. Vol. 1. Ascomycetes. Nordsvamp: Copenhagen. 309 pp.

***Amaurodon sumatranus* (Thelephorales, Basidiomycota), a new species from Indonesia**

OTTO MIETTINEN¹ & URMAS KÖLJALG²

otto.miettinen@helsinki.fi

¹ Finnish Museum of Natural History, Botanical Museum
P.O.Box 7, FI-00014 University of Helsinki, Finland

urmas.koljalg@ut.ee

² Institute of Botany and Ecology, University of Tartu
40 Lai St., EE-51005 Tartu, Estonia

Abstract—*Amaurodon sumatranus*, a resupinate thelephoroid species of *Basidiomycota*, is described from Sumatra, Indonesia. It is related to *A. viridis* and characterised by its turquoise to green, hydroid hymenophore and broadly ellipsoid, verrucose spores. Both known collections derive from endangered peat swamp forests of the province of Riau.

Key words—taxonomy, rainforest, Southeast Asia

Introduction

Amaurodon is a small genus of currently eight species belonging to the thelephoroid fungi (*Thelephorales*, *Basidiomycota*). The genus is characterised by the resupinate, lignicolous fruit-bodies with poroid, hydroid or smooth hymenophore, and blue to green colour, along with the violet or bluish violet reaction of spores in KOH, best seen before placing the cover glass on the preparate (Burdvall & Setliff 1974, Kõljalg 1996, Kõljalg & Ryvarden 1997, Agerer & Bougher 2001). *Amaurodon* is closely related to other resupinate thelephoroid genera, viz. *Pseudotomentella*, *Tomentella* and *Tomentellopsis*. All these genera are well-known ectomycorrhiza formers and have a worldwide distribution (Gardes & Bruns 1996, Chambers et al. 1998, Erland & Taylor 1999, Kõljalg et al. 2000, 2002). There is no evidence, however, that species of *Amaurodon* form mycorrhizas.

One of us (O.M.) found two strikingly coloured specimens of *Amaurodon* during his collecting trip to Indonesia in 2002. Both were collected from rotting wood well above ground in a peat swamp forest of the east coast of Sumatra, Indonesia. They proved to be conspecific and related to the species complex

of *A. viridis* (Alb. & Schwein. : Fr.) J.Schröt. Morphological and DNA-based analyses showed that they represent a distinct species, which is here described as the first species from the Old World tropics as *A. sumatranus*.

Materials and methods

During microscopic studies the basic mountant medium used was Cotton Blue (CB), but also 5% KOH was used (see Miettinen et al. 2006 for further detail). Spore and other measurements were made and illustrations were drawn in CB. Measurements were done using $\times 1000$ magnification and phase contrast illumination.

The following symbols are used for spore measurements: L = mean length, W = mean width, Q = L/W, i.e. average length divided by average width, Q' = length/width ratio of individual spores, n = number of spores measured from given number of specimens, for instance 90/3 means 90 spores measured from 3 specimens. In presenting the variation of spore size and Q', the whole range is given in parentheses. The 90% range excluding the extreme 5% of values from both ends is given without parentheses. Whenever the figures within and outside parentheses are identical, parentheses are omitted.

DNA from dried fungal basidiocarps of *A. sumatranus* (holotype), *A. hydroides* Kõljalg & Ryvarden (isotype in TAA), *A. viridis* (TAA149664), and *A. aquicoeruleus* Agerer (isotype in M) was extracted. The internal transcribed spacers ITS1 and ITS2, and 5.8S regions of nuclear ribosomal DNA were amplified, sequenced and phylogenetic analyses carried out following the methods described in Kõljalg et al. (2000). Sequences are kept in European Molecular Biology Laboratory (EMBL, accession nos AM490941–AM490944) and in UNITE (Kõljalg et al. 2005, accession nos UDB000294 and UDB002293–UDB002295).

Species description

Amaurodon sumatranus Miettinen & Kõljalg sp. nov.

Fig. 1–2

MYCOBANK MB510556.

Basidioma resupinatum, byssoideum, separabile. Hymenium hydnceum, aculeis brevis, circa 1 mm longis, aliquantum spathulatis, subcaerulescens vel luteolo-viride. Systema hypharum monomiticum, hyphae tenuitunicatae, hyalinae vel leviter crassitunicatae, rufescens. Cystidia nulla. Basidiosporae ellipsoideae, verruculosae, leviter crassitunicatae, luteo-fuscae, 4.7–5.7 $\times$ 3.7–4.7 μ m.

HOLOTYPE—Indonesia. Sumatra, Riau: Danau Pulau Besar / Danau Bawah Nature Reserve, on angiosperm tree stump, N 0°40': E102° 16', 13.IV.2002 O. Miettinen 5877 (BO, isotypes in H and TU).

ETYMOLOGY—Epithet refers to the place of collecting of the species, island of Sumatra.

ITS rDNA SEQUENCE ACCESSION NUMBERS—EMBL AM490943, UNITE UDB002294.

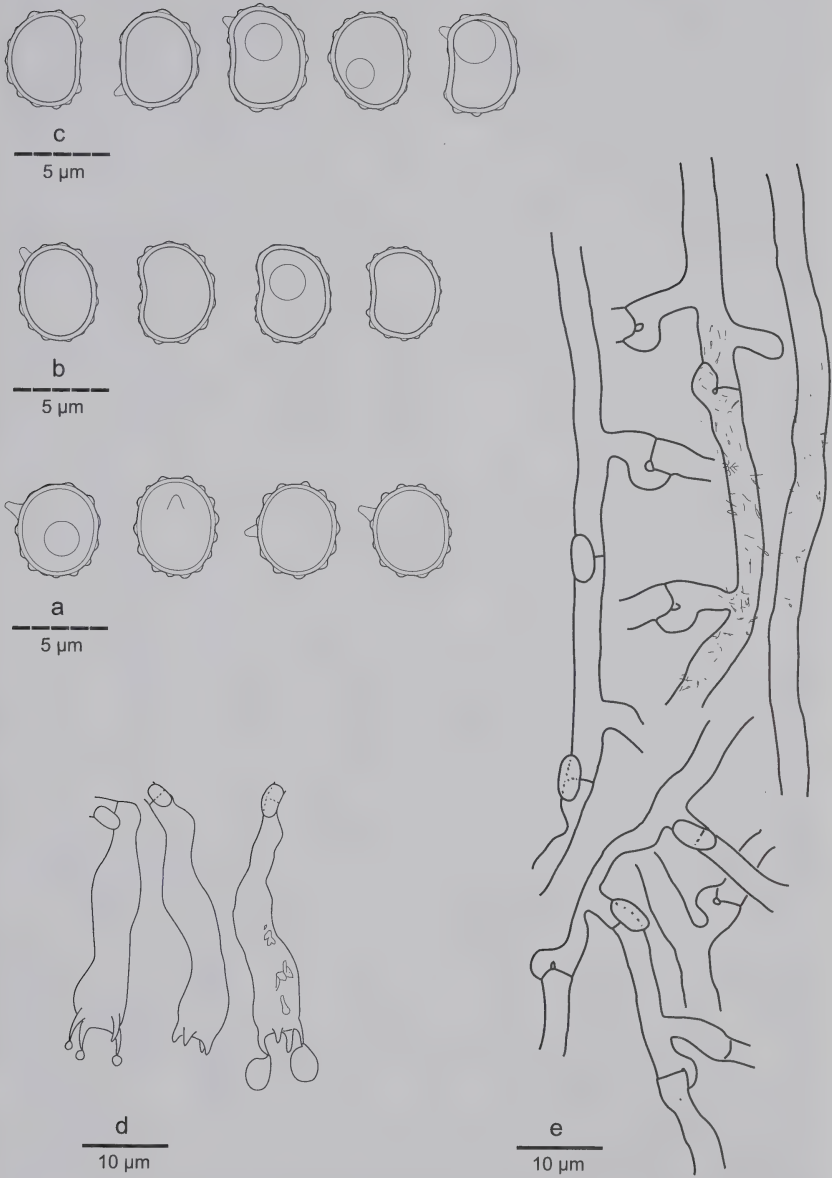


Fig. 1. *Amaurodon viridis*, lectotype, a) spores; *Amaurodon hydroides*, isotype, b) spores; *Amaurodon sumatranus*, holotype, c) spores, d) basidia, e) subicular hyphae.

Basidiocarp resupinate, size ranging from small patches of less than 1 cm² up to a confluent area of about 100 cm², easily separable from substrate, byssoid, intensive dark turquoise when fresh, drying yellowish green. Surface sparsely hydroid, spines mostly 1 mm long or shorter but longest spines up to 2 mm, typically somewhat spatulate, reminiscent of shark teeth. Subiculum approximately 0.05–0.1(–0.2) mm thick. Margin not differentiated, mycelial cords absent.

Hyphal system monomitic, all septa with clamps, structure loose, rather uniform throughout the basidiocarp. Small crystal grains and rods on hyphae here and there seen in CB, abundant in water. Green pigment abundant as amorphous matter in KOH.

Hyphae thin-walled and hyaline in hymenium and subhymenium; richly branched and (1.8–)2.0–3.2(–3.7) µm in diameter in subhymenium; slightly thick-walled and yellowish–brownish in trama and subiculum, (2.3–)2.8–4.0(–4.9) µm in diameter, in water partially staining bluish violet, CB(+) to CB–, plasma light blue in CB.

Basidia long, clavate and winding, occasionally constricted, (14.5–)16.5–27.5(–28.5) × (4.8–)5.2–6.3(–6.7) µm, L=22.5 µm, W=5.7 µm, n=46/2, with four curved, basally broad, 2–4 µm long sterigmata.

Basidiospores broadly ellipsoid to short phaseoliform in lateral face, ellipsoid in frontal face, verruculose, slightly thick-walled, yellow in CB, slightly CB+ to CB–, greyish-brownish in distilled water and turning violet in KOH, although the violet colour may fade under the cover glass. Ventral side concave, straight or convex. Warts barely projecting, at most 0.2 µm high. Spores (4.5–)4.7–5.7(–6.6) × (3.5–)3.7–4.7(–5.3) µm, L=5.1 µm, W=4.1 µm, Q'=1.1–1.3(–1.5), Q=1.24, n=120/2.

Distribution and ecology. The known collections come from a single natural forest area in the east coast of Sumatra, Indonesia. Both grew on standing angiosperm wood in middle stages of decay, with the basidiocarps well above soil. It has not been collected from the other parts of Indonesia despite months of field work by one of us (O.M.). Because of its vivid colour it is not easily overlooked, and thus can be considered uncommon.

The habitat of the finds is peat swamp forest, a type of rainforest growing on acid peat soil. Half of Asia's peat swamp forests are found in Indonesia and are experiencing rapid conversion and draining there and elsewhere (Rieley & Page 2005). The specimens were collected in a nature reserve adjacent to the largest remaining peat swamp forest area in Sumatra, Kampar Peninsula. Both the reserve and the larger area are acutely threatened by deforestation and collapse of hydrology (Hooijer 2005).

Ectomycorrhizal tree species of the family *Dipterocarpaceae* are common at the collecting site. Although *Amaurodon* has not been recorded in studies

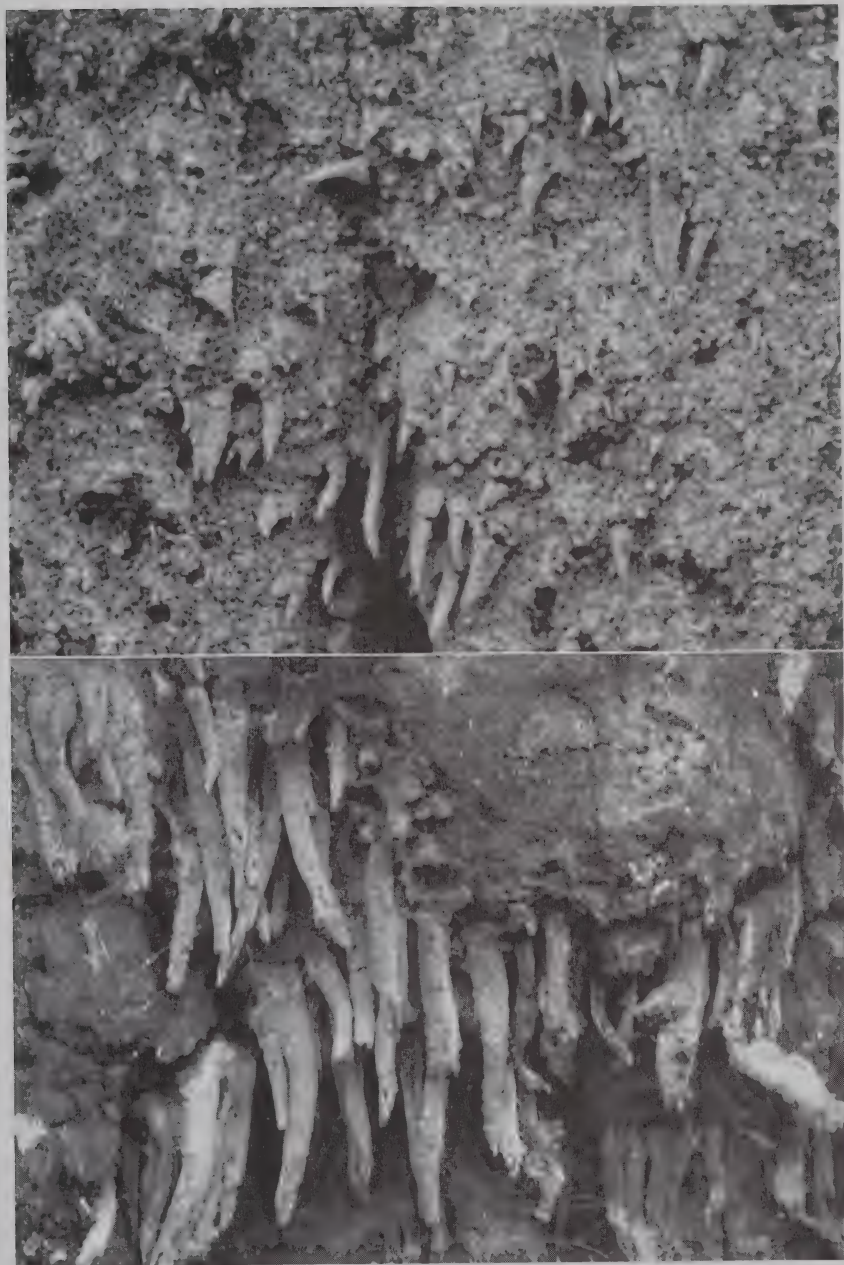


Fig. 2. Hymenophore of *Amaurodon sumatranus* (above, isotype in H) and *A. hydroides* (below, isotype in O), magnification $\times 13.7$.

of mycorrhizal communities so far, it is nevertheless probable that it forms ectomycorrhiza like its closest relatives. Since the species in the genus are rare they would easily be missed in mycorrhizal studies.

Remarks. *Amaurodon sumatranus* is characterised by its turquoise to green, sparsely hydroid hymenophore with short and somewhat spatulate spines, and broadly ellipsoid to phaseoliform, verrucose spores. This combination of microscopic and macroscopic characters sets it apart from closely related species. It is the only species of *Amaurodon* so far described (and reported as far as we know) from tropical Asia.

A temperate species *A. viridis* develops often small aculei like *A. sumatranus*. The aculei of *A. viridis* are generally smaller, 0.5(–0.7) mm at most and usually shorter. Its spores are subglobose, always with convex ventral side, and in average wider than those of *A. sumatranus*. The small difference in shape can be seen in Q-values of the spores (Tab. 1). Australian *A. aquicoeruleus* is closely related to or conspecific with *A. viridis*. Its basidiocarp is smooth or minutely granulose, and it has similarly subglobose spores as *A. viridis*, albeit slightly larger than in the material of *A. viridis* studied here. Agerer & Bougher (2001) reported a difference in spore colour between *A. aquicoeruleus* and *A. viridis* when observed in water. We found hyphae and individual spores turning faintly lilac in distilled water in the isotype of *A. aquicoeruleus*. We have not seen a similar reaction in *A. viridis*, but we can not assess the taxonomic importance of this character based on the few specimens studied here.

A. hydroides was described recently from Venezuela (Kõljalg & Ryvarden 1997). Its hymenophore consists of dense, slender, regularly cylindrical spines

Table 1. *Amaurodon* species: basidiospore measurements of the specimens studied, and combined statistics for each species (in bold).

Specimen	Length (µm)	L	Width (µm)	W	Q'	Q	n
<i>A. aquicoeruleus</i>	4.8–5.5	5.12	4.2–5.0(–5.2)	4.56	1.0–1.2	1.12	30
<i>A. hydroides</i>	(4.2–)4.5–5.7(–6.0)	4.89	(3.4–)3.5–4.5(–4.6)	3.92	1.1–1.4	1.25	61/2
isotype (0)	(4.5–)4.6–5.2(–5.4)	4.93	(3.4–)3.5–4.1(–4.3)	3.84	1.2–1.4	1.29	31
Ryvarden 37853	(4.2–)4.4–5.8(–6.0)	4.85	(3.5–)3.6–4.6	4.00	1.1–1.3	1.21	30
<i>A. sumatranus</i>	(4.5–)4.7–5.7(–6.6)	5.11	(3.5–)3.7–4.7(–5.3)	4.11	1.1–1.5	1.24	120/2
holotype	(4.5–)4.6–5.3(–5.6)	4.98	(3.5–)3.7–4.4(–4.5)	3.97	1.1–1.4	1.25	60
Miettinen 5670	(4.6–)4.8–6.1(–6.6)	5.24	3.8–4.5(–4.9)	4.17	1.1–1.5	1.23	60
<i>A. viridis</i>	(4.0–)4.3–5.4(–5.7)	4.83	(3.7–)3.9–4.8(–5.0)	4.25	1.1–1.3	1.14	120/4
lectotype	(4.2–)4.3–5.6(–5.7)	4.90	(3.8–)3.9–4.9(–5.0)	4.29	1.1–1.3	1.14	30
Nylander 17.III.1863	(4.2–)4.5–5.1(–5.3)	4.87	4.0–4.6(–4.8)	4.26	1.1–1.2	1.14	30
Ryvarden 22811	(4.0–)4.2–5.4(–5.6)	4.77	(3.7–)3.8–4.7(–5.0)	4.20	1.1–1.2	1.13	30
Ryvarden 43426	(4.3–)4.4–5.4(–5.6)	4.78	(3.8–)3.9–4.6(–5.0)	4.23	1.1–1.3	1.13	30

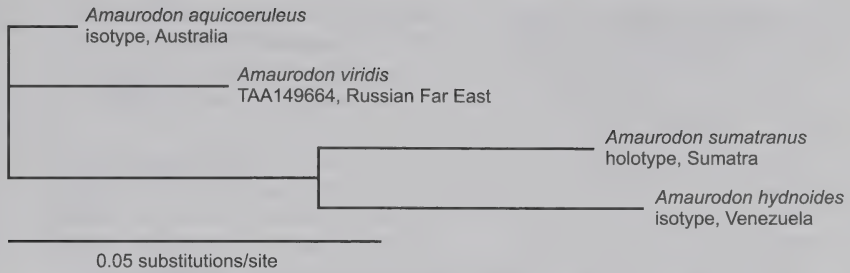


Figure 3. A neighbour-joining tree of four *Amaurodon* species, using the Hasegawa-Kishino-Yano (HKY85) substitution model.

of approximately 2 mm in length. In contrast the spines of *A. sumatranus* are sparse, usually 1 mm long, and commonly somewhat spatulate (Fig. 2). Microscopically the two are very similar. Rhomboidal large crystals, abundant in *A. hydroides*, were not found in *A. sumatranus* when studied in CB.

Table 2. ITS rDNA sequence pairwise base differences of four *Amaurodon* species.

Species pair	Proportion of sites differing	Pairwise base difference
<i>A. aquicoeruleus</i> versus <i>A. viridis</i>	22/585	3.8%
<i>A. aquicoeruleus</i> versus <i>A. sumatranus</i>	47/583	8.0%
<i>A. aquicoeruleus</i> versus <i>A. hydroides</i>	52/580	9.3%
<i>A. viridis</i> versus <i>A. sumatranus</i>	60/597	10.0%
<i>A. viridis</i> versus <i>A. hydroides</i>	61/594	10.3%
<i>A. sumatranus</i> versus <i>A. hydroides</i>	46/603	7.6%

ITS rDNA-based analysis confirms the status of *A. sumatranus* as a distinct species (Tab. 2). The closest species is *A. hydroides* which differs by 7.6%. These two species clustered also together in a neighbour joining tree (Fig. 3). The isotype of *A. aquicoeruleus* and a specimen of *A. viridis* collected in Russian Far East are closely related differing by 3.8% (22 base pairs from 585 are different). Tedersoo et al. (2006) selected 98% of ITS sequence identity as a value of a molecular species criterion for the resupinate theleporoid fungi. This figure (98% identity or 2% base difference) seems to be rather conservative (Kõljalg et al., unpublished data). However, in this study we have sequenced a single specimen per species only. Therefore we can not eliminate the possibility that *A. viridis* and *A. aquicoeruleus* will be synonyms based on the 2.0% threshold, when more specimens are sequenced. To solve the status of *A. aquicoeruleus*, a global survey of *A. viridis* would be needed.

SPECIMENS STUDIED—*Amaurodon aquicoeruleus*. **Australia**. Western Australia, Stewart Road, 3.7 km east of Brockman Highway, between Nannup and Augusta, on dead wood of *Eucalyptus marginata* or *E. calophylla*, 24.VIII.1999 R. Agerer & N. Bougher (isotype M).

Amaurodon hydnoides. **Venezuela**. Esta Bolivar: Las Nieves, on dead hardwood, 12.VI.1995 L. Ryvarden 37576 (isotypes O, TAA); L. Ryvarden 37853 (O, H).

Amaurodon sumatranus. **Indonesia**. Sumatra, Riau: Danau Pulau Besar / Danau Bawah Nature Reserve, on angiosperm log on the ground, N 0°40': E 102°16', 10.IV.2002 O. Miettinen 5670 (BO, H); see also holotype.

Amaurodon viridis. **Finland**. Uusimaa: Helsinki, Kaivopuisto ("Brunnsparken"), on rotten *Alnus*, 17.III.1863 W. Nylander (H). **Italy**. Sardinia, Nuoro Province: Lago Alto Flumenosa Fiume, on *Alnus glutinosa*, 29.XI.2000, L. Ryvarden 43426 (O, H). **Russia**. Primorye: Distr. Ternei, Sichote-Alin Nature Reserve, Maisa, on dead *Betula*, 14.IX.1990 R.H. Petersen (TAA149664). **United States**. California: San Diego County, Mt. Palomar Road, on *Quercus*, 19.III.1985 L. Ryvarden 22811 (O, H). Pennsylvania: Bethlehem, L. D. Schweinitz 562 (lectotype PH).

Acknowledgments

We thank Tom May (Melbourne) and Leif Ryvarden (Oslo) for reviewing the article. Leif Ryvarden also provided material for the study. Tuomo Niemelä (Helsinki) gave valuable comments to the manuscript. Teuvo Ahti (Helsinki) kindly revised the Latin description. Caltex Indonesia assisted with logistics. Emil Aaltonen Foundation (Finland), Norway's Research Council and Estonian Science Foundation (grant no 6606) provided financial support.

Literature cited

- Agerer R, Bougher NL. 2001. *Amaurodon aquicoeruleus* (Thelephoraceae, Hymenomycetes, Basidiomycota), a new species from Australia with spores distinctly blue in water. Australian Systematic Botany 14: 599–606.
- Burdall HH, Setliff EC. 1974. pH-related color changes in certain species of *Lazulinospora*, *Pseudotomentella*, and *Tomentella*. Mycologia 66: 101–106.
- Chambers SM, Sharples JM, Cairney JWG. 1998. Towards a molecular identification of the *Pisonia* mycobiont. Mycorrhiza 7: 319–321.
- Erland S, Taylor AFS. 1999. Resupinate ectomycorrhizal fungal genera. 347–363, in JWG Cairney, SM Chambers (eds.), Ectomycorrhizal fungi: key genera in profile. Heidelberg, Springer Verlag.
- Gardes M, Bruns TD. 1996. Community structure of ectomycorrhizal fungi in a *Pinus muricata* forest: above- and below-ground views. Canadian Journal of Botany 74: 1572–1583.
- Hooijer A. 2005. Hydrological assessment of forest plantation impacts on tropical forested peatlands; Kampar Peninsula, Sumatra, Indonesia. Technical Report Q3975, WL | Delft Hydraulics.
- Kõljalg U. 1996. *Tomentella* (Basidiomycota) and related genera in Temperate Eurasia. Synopsis Fungorum 9: 1–213.
- Kõljalg U, Ryvarden L. 1997. A new species of *Amaurodon* (Basidiomycota, Aphyllophorales). Mycotaxon 65: 107–111.
- Kõljalg U, Dahlberg A, Taylor AFS, Larsson E, Hallenberg N, Stenlid J, Larsson KH, Fransson PM, Kären O, Jonsson L. 2000. Diversity and abundance of resupinate thelephoroid fungi as ectomycorrhizal symbionts in Swedish boreal forests. Molecular Ecology 9: 1985–1996.
- Kõljalg U, Tammi H, Timonen S, Agerer R, Sen R. 2002. ITS rDNA sequence-based positioning of Pink-type ectomycorrhizas and *Tomentellopsis* species from boreal and temperate forests. Mycological Progress 1: 81–92.

- Kõljalg U, Larsson KH, Abarenkov K, Nilsson RH, Alexander IJ, Eberhardt U, Erland S, Hoiland K, Kjoller R, Larsson E, Pennanen T, Sen R, Taylor AFS, Tedersoo L, Vrålstad T, Ursing BM. 2005. UNITE: a database providing web-based methods for the molecular identification of ectomycorrhizal fungi. *New Phytologist* 166: 1063–1068.
- Miettinen O, Niemelä T, Spirin W. 2006. Northern *Antrodiella* species: the identity of *A. semisupina*, and type studies of related taxa. *Mycotaxon* 96: 211–239.
- Rieley JO, Page SE. 2005. Wise use of tropical peatlands: focus on Southeast Asia. Wageningen, Alterra.
- Tedersoo L, Suvi T, Larsson E, Kõljalg U. 2006. Diversity and community structure of ectomycorrhizal fungi in a wooded meadow. *Mycological Research* 110: 734–748.

Four new Chinese records of *Petriella* and *Pseudallescheria* (*Microascales*)

GUANGYU SUN, JUNLIN ZHANG, RONG ZHANG

sgy@nwsuaf.edu.cn

College of Plant Protection, Northwest A&F University
Yangling, Shaanxi, 712100, China

Abstract—The ascomycete genera *Petriella* and *Pseudallescheria* are reported for the first time from China. Two species of *Petriella* (*P. guttulata*, *P. sordida*) and two species of *Pseudallescheria* (*Ps. boydii*, *Ps. ellipsoidea*) were found on plant debris and soil from Shaanxi Province and Gansu Province, China.

Key words—taxonomy, *Petriella guttulata*, *Petriella sordida*, *Pseudallescheria boydii*, *Pseudallescheria ellipsoidea*

Introduction

Petriella Curzi is erected by Curzi in 1930 (Kirk et al. 2001). The type species is *P. sordida*. Corlett (1966) added *Petriella* to the family *Microascaceae*. Barron et al. (1961a) noted that the genus is characterized by predominantly asymmetrical, honey-coloured to reddish-brown, hairy ascocarps. Corlett (1963, 1966) observed that asci developed directly from filamentous ascogenous hyphae, not croziers. The species of the genus grow mostly on soil, animal dung and plant seeds (Barron et al. 1961b). The specific characters of *Petriella* are the ostiolate ascocarps and the reddish brown, often asymmetrical ascospores (Arx et al. 1988, Barr 1990).

The genus *Pseudallescheria* Negroni & I. Fischer is also in the *Microascaceae*. A notable addition to the amended family description is the inclusion of species with non-ostiolate ascocarps (Benny & Kimbrough 1980; Barr 1990). The presence or absence of an ostiole is probably not significant above the generic level (Cain 1956). Thus, the non-ostiolate genera *Kernia* and *Petriellidium* (a genus based on *Allescheria boydii*) are included in the *Microascaceae* because they fit the family concept in every other way (Malloch 1970, Arx 1973). Examination of the type specimens for *Petriellidium* and *Pseudallescheria* has revealed that these two genera are congeneric and *Petriellidium* is a later synonym of *Pseudallescheria* (McGinnis et al. 1982). *Pseudallescheria* is characterised by ascocarps that are usually non-ostiolate, while the ascospores

are symmetrical and usually yellowish or rarely reddish (Benny & Kimbrough 1980). In this paper we provide the first descriptions of *P. guttulata*, *P. sordida*, *Ps. ellipsoidea* and *Ps. boydii* collected in China.

Materials and methods

Cultures were isolated from plant debris and soil during 2005-2006 (Sun et al. 2004) and were grown on potato dextrose agar (PDA, 200 g potato, 20 g dextrose, 15 g agar, 1000 ml distilled water), and cornmeal agar (CMA, 20 g cornmeal, 15 g agar, 1000 ml distilled water). For morphological studies, subcultures of all isolates were grown in glass petri dishes on PDA, at 25°C, in the dark. The morphological characteristics, including diameter of the colonies were determined 4 weeks after subculturing; photographs were also taken.

Taxonomic description

Petriella guttulata G.L. Barron & Cain, Can. J. Bot. 39: 841. 1961. Fig.1(A-B)

≡ *Microascus guttulatus* (G.L. Barron & Cain) Lodha, Taxonomy of Fungi (Proc. Int. Symp. Madras, 1973) 1: 254. 1978.

Colonies at 25°C with a daily growth rate of 2-3 mm, white when young, turning pale greyish and blackish with age. Growth is irregularly zonate. Ascomata produced abundantly, at first in the aerial hyphae, later in and on the agar, especially to the outside of the colonies in older cultures; ascomata black, carbonaceous, subglobose to pyriform, 100-250 µm in diameter, with papillate ostiole, hairs forming a dense mat round the ascomata, usually short, septate, pigmented, smooth, about 100 × 1.5 µm; asci ovoid to broadly clavate, 18-28 × 12-18 µm; ascospores plano-convex to concavo-convex in side view, ellipsoid in face view, 8.5-10 × 4.5-5.5 µm, single-celled, red-brown in color, containing a few (usually two) large oil droplets and several smaller oil droplets, extruded at maturity as a ball at the mouth of the ascomata or as a long dark-brown cirrhous in older cultures.

Specimen examined: soil, Yangling, Shaanxi, HMUABO 82297-1.

Petriella sordida (Zukal) G.L. Barron & J.C. Gilman, Can. J. Bot. 39: 839. 1961.

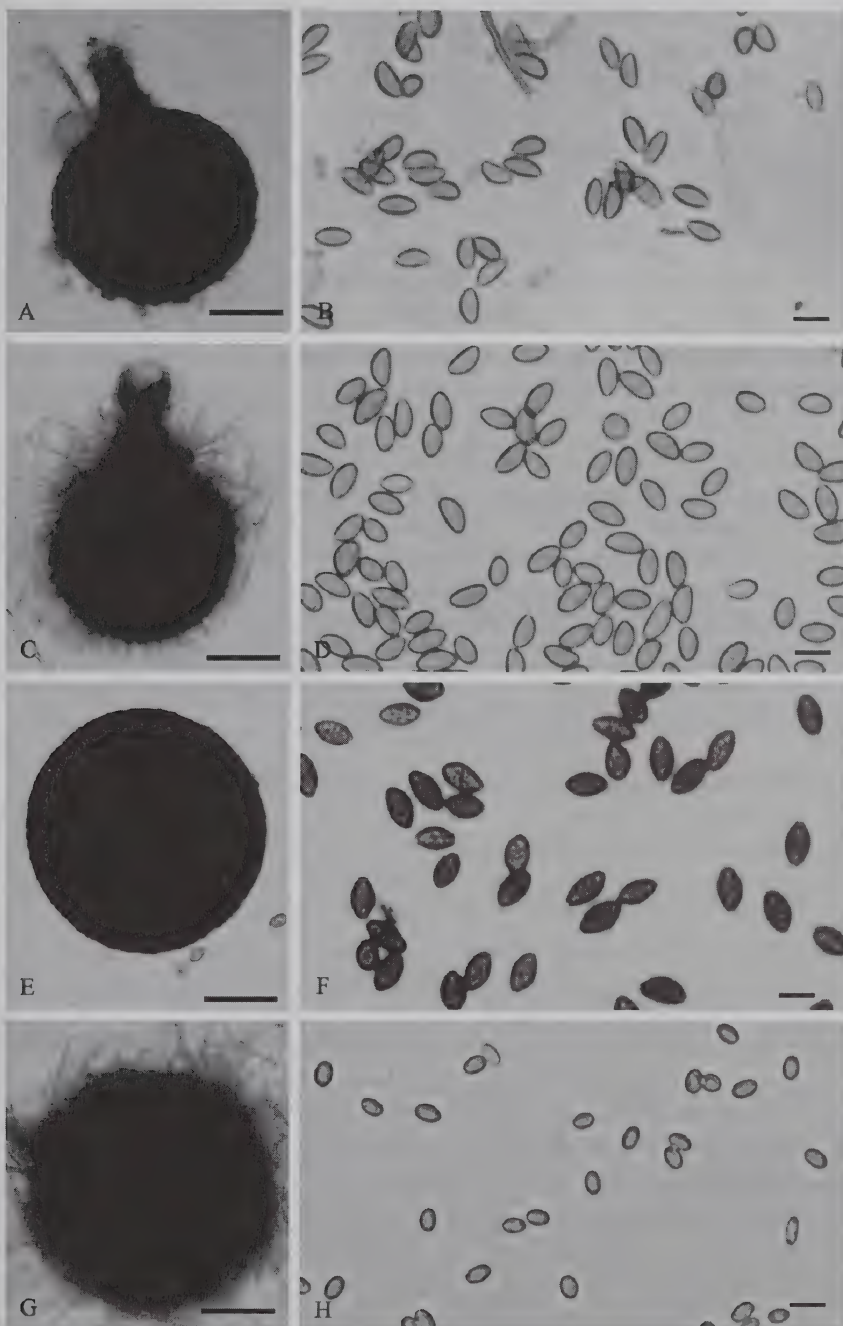
Fig.1(C-D)

≡ *Microascus sordidus* Zukal, Ber. dt. Bot. Ges. 8: 295. 1890.

Colonies at 25°C with a daily growth rate of 2-3 mm, white when young, pale greyish with age, without distinct aerial mycelium; ascomata usually superficial,

Fig1. A: ascoma of *Petriella guttulata*; B: ascospores of *P. guttulata*; C: ascoma of *P. sordida*; D: ascospores of *P. sordida*; E: Ascoma of *Pseudallescheria ellipsoidea*; F: ascospores of *Ps. ellipsoidea*; G: ascoma of *Ps. boydii*; H: ascospores of *Ps. boydii*.

Scale bars: A, C, E, G = 50 µm; B, D, F, H = 10 µm.



occasionally immersed in substances, spherical or ampulliform, black in reflected light, 190-350 μm in diameter; with a cylindrical, up to 300 μm long and 60-90 μm broad beak, usually covered with some seta-like, septate, brown hairs; ascomatal wall dark, composed of several layers of flattened cell; asci obovate or broadly clavate, 8-spored, evanescent; ascospores elongate, reniform or slightly lunate in lateral view, aseptate, dextrinoid when young, pale reddish brown when mature, $9-11 \times 4.5-6 \mu\text{m}$, with a distinct germ pore at both ends, extruded as a sticky, copper coloured mass.

Specimen examined: plant debris, Tianshui, Gansu, HMUABO 822302-1.

Pseudallescheria ellipsoidea (Arx & Fassat.) McGinnis, A.A. Padhye & Ajello,

Mycotaxon 14: 98. 1982.

Fig.1(E-F)

=*Petriellidium ellipsoideum* Arx & Fassat., Persoonia 7: 370. 1973.

Colonies at 25°C with a daily growth rate of 2.5-3 mm, pale greyish, with a floccose or lanose aerial mycelium, reddish brown with age; ascomata immersed or semi-immersed, spherical, non-ostiolate, smooth or covered with hyphae, brown, 75-180 μm in diameter; ascomatal wall 4-7 μm thick, reddish brown, textura epidermoidea in surface view; asci obovate or spherical, 8-spored, very evanescent; ascospores broadly ellipsoidal, rounded at both ends, dextrinoid when young, pale straw coloured when mature, $7-9 \times 5-6 \mu\text{m}$, with two germ pores.

Specimen examined: soil, Taibai, Shaanxi, HMUABO 822118-1.

Pseudallescheria boydii (Shear) McGinnis, A.A. Padhye & Ajello,

Mycotaxon 14: 97. 1982.

Fig.1(G-H)

=*Allescheria boydii* Shear, Mycologia 14: 242. 1922.

=*Petriellidium boydii* (Shear) Malloch, Mycologia 62: 738. 1970.

=*Pseudallescheria shearii* Negroni & I. Fisch., Prensa Med. Argent. 30: 2398. 1943.

Colonies at 25°C with a daily growth rate of 4-5 mm, white or pale when young, with grey or brown shades when old, floccose or lanose; ascomata usually submerged, spherical, non-ostiolate, 140-200 μm in diameter, often covered with brown, thick-wall, septate, 2-3 μm broad hyphae; ascomatal wall 4-6 μm thick, composed of 2-3 layers of flattened, 2-6 μm broad cells, textura epidermoidea in surface view; asci obovate or nearly spherical, 8-spored, evanescent; ascospores ellipsoidal, symmetrical or slightly asymmetrical, dextrinoid when young, straw colored when mature, $6-7 \times 3.5-4 \mu\text{m}$, with two germ pores.

Specimen examined: soil, Taibai, Shaanxi, HMUABO 822111-1.

Acknowledgments

This work was supported by National Natural Science Foundation of China (NSFC, No. 30670013) and Program for Changjiang Scholars and Innovative Research Team in University (No. 200558). The authors wish to thank Dr Eric H C McKenzie (Landcare Research, Private Bag 92170, Auckland, New Zealand) and Professor Zhongyi Zhang (College of Plant Protection, Yunnan Agricultural University, Kunming, Yunnan, China) for reviewing our manuscript, and Dr Thomas Harrington (Department of Plant Pathology, Iowa State University, Ames, USA) for sending references.

Literature cited

- Arx JA von. 1973. The genera *Petriellidium* and *Pithoascus* (*Microascaceae*). *Persoonia* 7: 367-375.
- Arx JA von, Figueras MJ, Guarro J. 1988. Sordariaceous ascomycetes without ascospore ejaculation. *Nova Hedwigia* 94: 1-104.
- Barr ME. 1990. Prodomus to nonlichenized, pyrenomycetous members of class *Hymenoascmycetes*. *Mycotaxon* 39: 43-184.
- Barron GL, Cain RF, Gilman JC. 1961a. A revision of the genus *Petriella*. *Canadian Journal of Botany* 39: 837-845.
- Barron GL, Cain RF, Gilman JC. 1961b. The genus *Microascus*. *Canadian Journal of Botany* 39: 1609-1631.
- Benny GL, Kimbrough JW. 1980. A synopsis of the orders and families of plectomycetes with keys to genera. *Mycotaxon* 12: 1-91.
- Cain RF. 1956. Studies of coprophilous *Ascomycetes* II. *Phaeotrichum*, a new cleistocarpus genus in a new family, and its relationships. *Canadian Journal of Botany* 34: 675-687.
- Corlett M. 1963. The developmental morphology of two species of *Microascus*. *Canadian Journal of Botany* 41: 253-266.
- Corlett M. 1966. Developmental studies in the *Microascaceae*. *Canadian Journal of Botany* 44: 79-88.
- Kirk PM, Cannon PF, David JC, Stalpers JA. (eds). 2001. *Dictionary of the fungi*. 9th ed. Wallingford, CAB International.
- Malloch D. 1970. New concepts in the *Microascaceae* illustrated by two new species. *Mycologia* 62: 727-740.
- McGinnis MR, Padhye AA, Ajello L. 1982. *Pseudallescheria* Negroni et Fischer, 1943 and its later synonym *Petriellidium* Malloch, 1970. *Mycotaxon* 14: 94-102.
- Sun GY, Tan YJ, Zhang R. 2004. The family *Chaetomiaceae* from China I. Species of the genus *Chaetomium*. *Mycosystema* 23: 333-337.

New records of smut fungi from Korea. 1

CVETOMIR M. DENCHEV¹, YOUNG-JOON CHOI²,
SEUNG-KYU LEE³ & HYEON-DONG SHIN^{2*}

cmdenchev@yahoo.co.uk

¹*Institute of Life Science and Natural Resources
Korea University, Seoul 136-701, Korea*

yjchoi@korea.ac.kr & hdshin@korea.ac.kr

²*Division of Environmental Science and Ecological Engineering
Korea University, Seoul 136-701, Korea*

leesk77@foa.go.kr

³*Laboratory of Forest and Shade Tree Pathology
Korea Forest Research Institute, Seoul 130-712, Korea*

Abstract—Four species of smut fungi, *Kochmania oxalidis*, *Thecaphora thlaspeos*, *Urocystis syncocca*, and *Vankya vaillantii*, are reported for the first time from Korea. *Arabis serrata* is recorded as a new host of *Thecaphora thlaspeos*. A list of the correct names of the known smut fungi in Korea is also given.

Key words—plant pathogenic fungi, taxonomy, *Ustilaginomycetes*

Introduction

The diversity of the smut fungi in Korea (*Ustilaginomycetes* and *Microbotryales*) is poorly known, and still not intensively studied. No regional monographic study has been carried out yet. Some information about smut fungi in the region has been published in a few phytopathological articles. Up to date, only twenty-five species on twenty-three vascular plants have been reported, making thirty-two smut-host combinations (according to Cho & Shin 2004 and BPI database). The following species are currently known from Korea: *Eballistra oryzae* (Syd. & P. Syd.) R. Bauer et al., *Macalpinomyces neglectus* (Niessl) Vánky, *Sphacelotheca hydropiperis* (Schumach.) de Bary, *Sporisorium cruentum* (J.G. Kühn) Vánky, *S. reilianum* (J.G. Kühn) Langdon & Full., *S. sorghi* Ehrenb. ex Link, *Sporisorium* sp. on *Themeda triandra* Forssk., *Tilletia barclayana* (Bref.) Sacc. & P. Syd., *T. caries* (DC.) Tul. & C. Tul., *T. corona* Scribn., *T. laevis* J.G. Kühn, *Tranzscheliella*

*Author for correspondence

hypodytes (Schltdl.) Vánky & McKenzie, *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh., *Ur. magica* Pass., *Ur. tritici* Körn., *Ustilago avenae* (Pers. : Pers.) Rostr., *U. coicis* Bref., *U. crameri* Körn., *U. hordei* (Pers. : Pers.) Lagerh., *U. maydis* (DC.) Corda, *U. nuda* (J.L. Jensen) Kellerm. & Swingle, *U. shiraiana* Henn., *U. syntherismae* (Schwein.) Peck, *U. trichophora* (Link) Körn., and *U. tritici* (Pers. : Pers.) Rostr.

The four species listed in the present article represent new records of smut fungi from Korea. They were found by the senior author during examination of specimens in phanerogamic herbaria in Seoul. Duplicates of these specimens are housed in SOMF (Mycological Collection of the Institute of Botany, Bulgarian Academy of Sciences, Sofia, Bulgaria).

Materials and methods

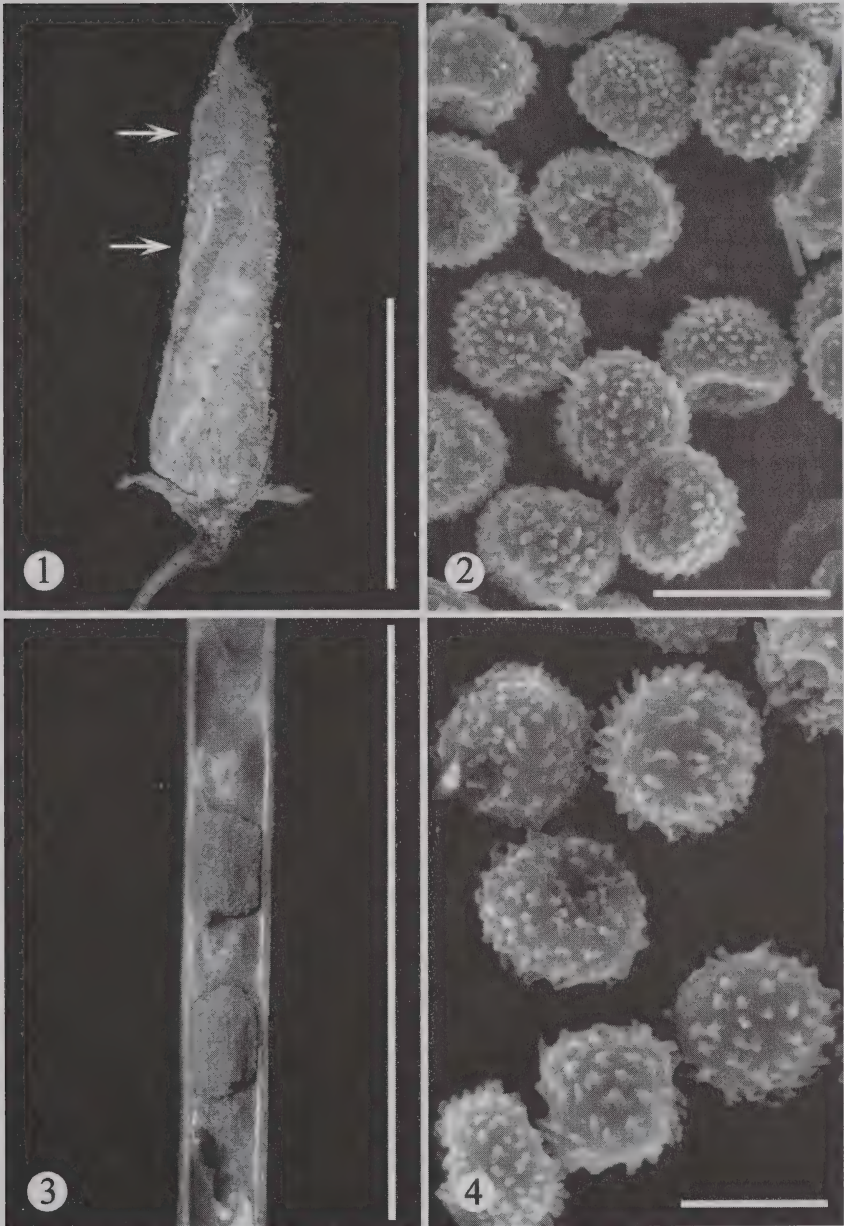
Material from the herbaria of College of Natural Sciences, Seoul National University, Seoul (SNU) and Korea University, Seoul (KUS) was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean $\pm$ 1 standard deviation). In the description, the symbol 'n/_x' is used to indicate the total numbers of measured collections, and spore balls or spores, respectively. For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum with a Hitachi E-1010 ion sputter. The surface structure of spores was observed at 15 kV and photographed with a Hitachi S-3500N scanning electron microscope.

New records

Kochmania oxalidis (Ellis & Tracy) M. Piątek, Mycotaxon 92: 34, 2005. Figs. 1-2
= *Ustilago oxalidis* Ellis & Tracy, J. Mycol. 6: 77, 1890.

Sori in seeds, filling the capsules with spore mass, inconspicuous. **Spore mass** powdery, yellowish brown. **Spores** mainly globose, subglobose or ovoid, rarely broadly ellipsoidal, light yellowish brown, 14-18 $\times$ 12.5-16.5 (16.2 $\pm$ 1.0 $\times$ 14.8 $\pm$ 0.9) μ m (n/₁=40), including the ornaments; wall 1-1.4 μ m thick, densely, irregularly echinate, spines up to 1.5 μ m high, often appear to anastomose at their bases.

SPECIMENS EXAMINED — On *Oxalis corniculata* L.: KOREA, Kyoungbuk Prov., Mt. Hyangro, 1 Jun 1972, leg. S.K. Kim (as *Xanthoxalis corniculata*) (SNU 46 729, SOMF 26 201); KOREA, sine loc., 31 May 1972, leg. Y.B. Yang (as *X. corniculata*) (SNU 46 728, SOMF 26 202).



Figs. 1-2. *Kochmania oxalidis* on *Oxalis corniculata* (SNU 46 729): 1. Sorus in a capsule; 2. Spores in SEM. Scale bars: 1 = 1 cm, 2 = 20 μ m. Figs. 3-4. *Thecaphora thlaspeos* on *Arabis serrata* var. *hallaisanensis* (SNU 4111): 3. Opened silique with a sorus in seeds; 4. Spores in SEM. Scale bars: 3 = 1 cm, 4 = 10 μ m.

Distribution. On *Oxalidaceae*: *Oxalis corniculata* (*Xanthoxalis corniculata* (L.) Small), *O. dillenii* Jacq. (*Xanthoxalis dillenii* (Jacq.) Holub), *O. fontana* Bunge, *O. stricta* L., Europe, Asia, North America, and South America.

Comments— The ornamentation is echinate (cfr also Kakishima 1982: 90) but not verruculose, as it is described in some recent publications (Vánky 1994, etc.). In Asia, this species is known from the Far East of Russia on *Oxalis dillenii* (Azbukina et al. 1995) and Japan and China on *O. corniculata* (Kakishima 1982, Guo 2000).

Thecaphora thlaspeos (Beck) Vánky, Mycotaxon 89: 111, 2004.

Figs. 3-4

≡ *Ustilago thlaspeos* (Beck) Lagerh., in Sydow, Ust. No. 118, 1897.

≡ *Bauhinus thlaspeos* (Beck) Denchev, Mycotaxon 65: 424, 1997.

≡ *Tothiella thlaspeos* (Beck) Vánky, Mycotaxon 70: 39, 1999.

Sori in seeds, filling the siliquae with inconspicuous spore mass which is released when the siliquae open. **Spore mass** powdery, light yellow-brown. **Spores** broadly ellipsoidal, subglobose, ovoid or irregular, $10\text{--}15.5 \times 10\text{--}12.5$ ($12.2 \pm 1.0 \times 10.7 \pm 0.7$) μm ($n_1=50$), including the ornaments, pale yellowish brown; wall $0.6\text{--}1$ μm thick, with irregularly arranged, coarse warts, tubercles or elongated ornaments, $0.5\text{--}1.8$ μm high.

SPECIMEN EXAMINED — On *Arabis serrata* Franch. & Sav. var. *hallaisanensis* (Nakai) Ohwi; KOREA, Jeju Prov., 17 July 1935, leg. P.S. Do (SNU 4111, SOMF 26 203).

Distribution. On *Brassicaceae*: *Alyssum*, *Arabis*, *Cardamine*, *Cardaminopsis*, *Draba*, *Erysimum*, and *Thlaspi*, Europe, Asia.

Comments— *Thecaphora thlaspeos* has been previously reported only from Europe (Vánky 2004). Here is the first Asian record found on a new host species, *Arabis serrata*. The Korean specimen has some differences in the spore morphology in comparison with European specimens: (i) lower maximum values of the length and width but without discreteness in their mean values (cfr Denchev 1991: 19, 2001: 127), (ii) more coarse and irregular ornaments, that are not more elongated on one of the sides, as they were reported to be characteristic of most specimens from Europe (cfr Vánky 1994: 380, 1999: 39, Denchev 1991, 2001).

Urocystis syncocca (L.A. Kirchn.) B. Lindeb., Symb. Bot. Upsal. 16(2): 99, 1959.

Sori on the leaves, hypophyllous, forming pustules, $3.5\text{--}6$ mm long, suborbicular to broadly elliptical in outline, at first covered by the epidermis which later ruptures to expose the spore balls. **Spore mass** powdery, black. **Spore balls** subglobose, broadly ellipsoidal, ovoid or irregular, $19.5\text{--}42 \times 14\text{--}36$ μm , composed of $1\text{--}6$ (~ 8) central spores [$1=9.8\%$, $2=17.9\%$, $3=25\%$, $4=26.3\%$, $5=12.5\%$, $6=6.3\%$, $7=1.8\%$, $8=0.4\%$; $n_1=224$] and a discontinuous layer of peripheral sterile cells. **Sterile cells** orbicular, suborbicular, broadly elliptical

or oval in outline, 8-15 μm long, light yellowish brown; wall 0.5-0.7 μm thick, smooth. **Spores** subglobose, broadly ellipsoidal or irregular, $12.5\text{--}19 \times 10\text{--}15$ ($14.3 \pm 1.7 \times 11.6 \pm 1.3$) μm ($n_1=45$), dark- or medium reddish brown; wall 1-2 μm thick, smooth.

SPECIMEN EXAMINED — On *Hepatica asiatica* Nakai: KOREA, Chungnam Prov., Boryeong, Ungcheon-eup, Duryong-ri, 275-meter Hill, 29 May 2004, leg. M.J. Song, H.J. Bang & Y.L. Oh (KUS 2004-0809, SOMF 26 204).

Distribution. On *Ranunculaceae*: *Hepatica acutiloba* DC., *H. americana* (DC.) Ker-Gawl., *H. asiatica*, *H. nobilis* Mill. (*H. triloba* Chaix), *H. transsilvanica* Fuss, Europe, Asia (Far East of Russia, Korea), and North America.

Comments— *Hepatica asiatica* is known as a host of this species from the Far East of Russia (Azbukina et al. 1995).

Vankya vaillantii (Tul. & C. Tul.) Ershad, Rostanihi 1(1-4): 69, 2000.

= *Ustilago vaillantii* Tul. & C. Tul., Ann. Sci. Nat. Bot., Sér. 3, 7: 90, 1847.

Sori in anthers. **Spore mass** greenish brown, powdery. Infection systemic. **Spores** variable in shape and size, mainly globose, subglobose, broadly ellipsoidal or ovoid, rarely irregularly angular, $5.5\text{--}11 \times 5\text{--}7.5$ ($7.0 \pm 1.1 \times 6.0 \pm 0.5$) μm ($n_1=60$), single spores curved, ellipsoidal to narrowly ellipsoidal, up to 12.5 μm long, light to middle greenish brown; wall ca 0.5 μm thick, verruculose.

SPECIMEN EXAMINED — On *Scilla scilloides* (Lindl.) Druce (*S. sinensis* (Lour.) Merr.): KOREA, Jeju Prov., Namjeju, Namwon-eup, Taeheung-ri, the seashore, $33^\circ 16' 54.5''$ N, $126^\circ 45' 05.3''$ E, 8 Oct 2005, leg. K.J. Kim, K.M. Ku & S.L. Bae (as *S. sinensis*) (KUS 2005-1372, SOMF 26 205).

Distribution. On *Liliaceae*: cosmopolitan.

Comments— *Scilla scilloides* is distributed in Far East Asia (China, Taiwan, Korea, and Japan). This plant has been previously found to be attacked by *Vankya vaillantii* in Japan (Kakishima 1982) and China (Guo 2000).

Acknowledgements

We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany), Dr Roger G. Shivas (Queensland Department of Primary Industries and Fisheries, Australia), and Dr Royall T. Moore (University of Ulster, Coleraine, Northern Ireland, UK) for critically reading the manuscript and serving as pre-submission reviewers; Directors and Curators of SNU (Herbarium of College of Natural Sciences, Seoul National University) and KUS (Herbarium of Korea University, Seoul) for permission to work with collections kept in their herbaria. This work was supported by the Korea Research Foundation and the Korean Federation of Science and Technology Societies Grant funded by Korea Government (MOEHRD, Basic Research Promotion Fund).

Literature cited

- Azbukina ZM, Karatygin IV, Govorova, OK. 1995. Class 1. *Ustomycetes* Moore. 9-205, in ZM Azbukina (ed.), *Plantae non vasculares, Fungi et Bryopsida orientis extremi rossica*, Fungi, 3. Nauka, Petropoli. (In Russian)
- Cho WD, Shin HD. 2004. List of plant diseases in Korea. Fourth edition. The Korean Society of Plant Pathology, Seoul.
- Denchev CM. 1991. New records of Bulgarian smut fungi (*Ustilaginales*). *Sydowia* 43: 15-22.
- Denchev CM. 2001. Classis *Ustomycetes* (Ordines *Tilletiales*, *Ustilaginales* et *Graphiolales*). 1-286, in V. Fakirova (ed.), *Fungi Bulgariae* 4. Editio Academica "Prof. Marin Drinov" & Editio Pensoft, Sofia. (In Bulgarian with an English summary)
- Guo L. 2000. *Flora Fungorum Sinicorum*. Vol. 12. *Ustilaginaceae*. Science Press, Beijing. (In Chinese)
- Kakishima M. 1982. A taxonomic study on the *Ustilaginales* in Japan. *Memoirs of Institute of Agriculture and Forestry, University of Tsukuba (Agricultural and Forestry Science)* 1: 1-124. (In Japanese)
- Vánky K. 1994. *European smut fungi*. Gustav Fischer Verlag, Stuttgart, Jena, New York.
- Vánky K. 1999. The new classificatory system for smut fungi, and two new genera. *Mycotaxon* 70: 35-49.
- Vánky K. 2004. Taxonomic studies on *Ustilaginomycetes* – 24. *Mycotaxon* 89: 55-118.

New records of smut fungi from Korea. 2

CVETOMIR M. DENCHEV¹, HYEON-DONG SHIN^{2*}
& SUNG MIN KIM³

cmdenchev@yahoo.co.uk

¹Institute of Life Science and Natural Resources, Korea University
Seoul 136-701, Korea

hdshin@korea.ac.kr

²Division of Environmental Science and Ecological Engineering
Korea University, Seoul 136-701, Korea

sm6656@sungshin.ac.kr

³Department of Biology, Sungshin Women's University
Seoul 136-701, Korea

Abstract—*Entorrhiza casparyana* is reported for the first time from Korea and Asia. This is the fourth record of this smut fungus on *Juncus tenuis*. As the mature galls and spores of *E. casparyana*, in all collections on *Juncus tenuis* known from Korea, Europe, and Costa Rica, are smaller than those on other hosts, a new variety is proposed and illustrated, viz. *Entorrhiza casparyana* var. *tenuis*.

Key words—*Entorrhizales*, plant pathogenic fungi, taxonomy, *Ustilaginomycetes*

Introduction

The genus *Entorrhiza* C.A. Weber (*Entorrhizales*, *Ustilaginomycetes*) is characterised by sori that form galls on roots of *Juncaceae* and *Cyperaceae* and having single, intracellular, thick-walled spores embedded in the root tissues. The species of this genus have a peculiar type of spore germination (Fineran 1982, Vánky 2002).

In 2006, during field investigations in Korea, the first author collected *Entorrhiza casparyana* on *Juncus tenuis*. This collection is reported herein. It represents not only a new species and genus record for the smut fungi of Korea but also a first record of this species from Asia. Among the twelve known species of *Entorrhiza*, only one species has been previously reported from Asia, viz.

*Author for correspondence

E. guttiformis M. Piepenbr. & S.R. Wang on *Carex parva* Nees, described from China (Wang & Piepenbring 2002).

Morphometric characters of the sorus and spores of *Entorrhiza casparyana* on *Juncus tenuis* were compared with the known information about this fungus on other hosts. Accordingly, the taxon on *Juncus tenuis* turned out to be a new variety.

Materials and methods

The collected specimens were deposited in the Mycological Collection of the Institute of Botany, Bulgarian Academy of Sciences, Sofia (SOMF). Herbarium material was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean $\pm$ 1 standard deviation). In the description, the symbol ' n/x ' is used to indicate the total numbers of measured collections and spores, respectively. For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum with a Hitachi E-1010 ion sputter. The surface structure of spores was observed at 15 kV and photographed with a Hitachi S-3500N scanning electron microscope.

A new Korean record of *Entorrhiza casparyana* and the taxonomic status of this species on *Juncus tenuis*

A comparative study of the Korean specimens with specimens of *Entorrhiza casparyana* on other hosts; together with an investigation of the scientific literature, indicate that *E. casparyana* on *Juncus tenuis* represents a new variety, which is described as:

Entorrhiza casparyana (Magnus) Lagerh., Hedwigia 27: 262, 1888 (Sept.-Oct.).

= *Schinzia casparyana* Magnus, Ber. Deutsch. Bot. Ges. 6: 103, 1888.

= *Entorrhiza casparyana* (Magnus) De Toni in Sacc., Syll. fung. 7(2): 497, 1888 (Oct. 28).

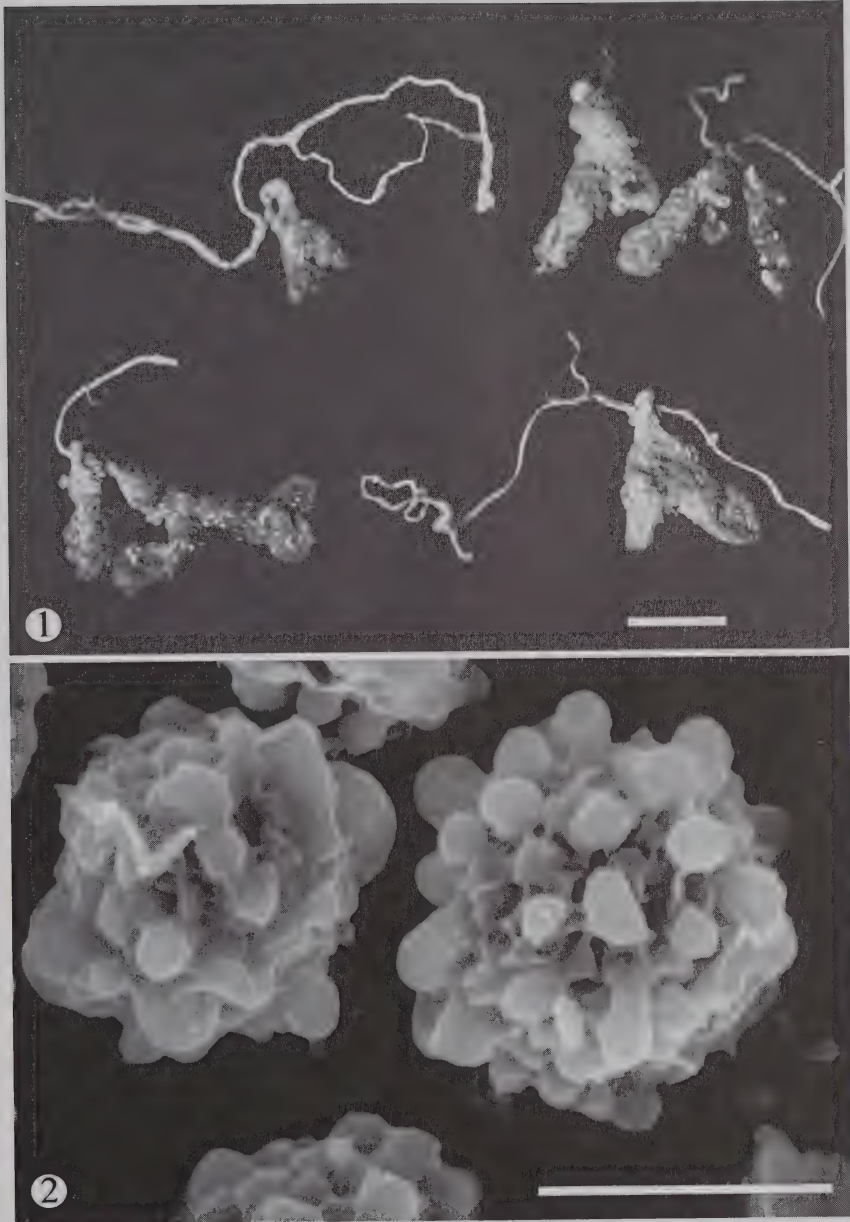
= *Entorrhiza digitata* Lagerh., Hedwigia 27: 264, 1888.

Entorrhiza casparyana var. *tenuis* Denchev & H.D. Shin, var. nov.

FIGS 1-2

MYCOBANK # MB 510557

Holotypus in matrice *Juncus tenuis* Willd., Korea, Gangwon Prov., prope oppidum Hoengseong, 37°31'24.82" N, 128°17'27.98" E, 7.IX.2006, leg. C.M. Denchev (SOMF 26 206). Paratypus in matrice *Juncus tenuis*, Korea, Gangwon Prov., prope oppidum Hoengseong, 37°31'24.84" N, 128°17'28.11" E, 7.IX.2006, leg. C.M. Denchev (SOMF 26 207).



Figs. 1-2. *Entorrhiza casparyana* var. *tenuis* from the roots of *Juncus tenuis* (SOMF 26 206, Holotypus). 1. Sori. 2. Spores in SEM. Scale bars: 1 = 1 mm, 2 = 10 μ m.

Sori gallae radices, 1.2-3 mm longi, sporis intracellulariter evolutis impleti. *Sporae* globosae vel subglobosae, $11.5-20 \times 10.5-20 \mu\text{m}$, tuberculatae vel verrucosae.

Etymology: derived from the epithet of the host plant.

Previously published description & illustrations: Denchev, Mycologia Balcanica 1: 49-50, figs. 1-2, 2004 (as *Entorrhiza casparyana*).

Sori on the roots forming elongated, often branched, dark brown galls, 1.2-3 mm long (Fig. 1), filled with intracellularly developing spores. **Spores** usually solitary, sometimes in pairs, globose or subglobose, $11.5-20 \times 10.5-20$ ($15.1 \pm 1.9 \times 14.3 \pm 1.7$) μm (including the ornamentations) ($n/_{\bar{x}}=100$), $L/w = 1.05$, light greenish brown; wall two-layered, the inner layer 0.5-1 μm thick, the outer layer variable in thickness ((0.5-) 1-6 μm , including the ornamentations), tuberculate or verrucose, with irregularly arranged, coarse tubercles or warts, seldom smooth; as seen by SEM, tubercles and warts partly confluent (Fig. 2).

Distribution. On *Juncus tenuis*, Asia (Korea), Europe (Austria, Romania), and Central America (Costa Rica). Certainly more common but overlooked.

Comments— The spore sizes, given in the description, are based on measurements of spores from the holotype and paratype specimens. *Entorrhiza casparyana* has been previously reported on *Juncus tenuis* from Romania (Mt Căliman – Fineran 1978: 23, Vánky 1985: 50), Austria (Graz – Denchev 2004: 49), and Costa Rica (Cartago, San José – Piepenbring 2003: 13). Vánky (l.c.) noted that on *Juncus tenuis*, “the apparently mature galls and spores are somewhat smaller than those produced on *J. articulatus* L.”. Measurements of the spores of the Austrian material on *J. tenuis* confirmed that conclusion, i.e., spores $13-21.5 \times 12.5-21.5$ ($16.8 \pm 1.5 \times 16.1 \pm 1.7$) μm ($n/_{\bar{x}}=100$), $L/w = 1.04$ (Denchev 2004). The spores of the Costa Rican specimen measured $12-15$ (-17) $\times$ $11-14$ (-15) μm (Piepenbring 2003).

For comparison, we give spore sizes of *E. casparyana* on other hosts, cited from the literature: chiefly 15-26 (sometimes up to 45) μm in diameter (on *Juncus alpinus* Vill., *J. arcticus* Willd., *J. articulatus* L., *J. filiformis* L., and *J. tenageia* Ehrh. from Europe, Zundel 1953), 12-26 (-41) μm in diameter (on *J. articulatus* and *J. gregiflorus* L.A.S. Johnson, Fineran 1971), (12-) 13.5-23 (-28) μm in diameter, occasionally much larger (on *J. alpinus*, *J. articulatus*, *J. bufonius* L., (?) *J. conglomeratus* L., *J. effusus* L., *J. gregiflorus*, *J. inflexus* L., and *J. tenageia*, results from a world revision made by Fineran 1978, and from New Zealand, Vánky & McKenzie 2002), 13-23 (-28) μm in diameter (on *J. articulatus*, *J. bufonius*, and *J. tenageia* from Germany, Scholz & Scholz 1988), 12-26 (-45) μm in diameter (on *J. geniculatus* Schrank from the European part of Russia, Azbukina & Karatygin 1995), $13-28 \times 12.5-25.5$ ($17.9 \pm 2.6 \times 17.1 \pm 2.5$) μm ($n/_{\bar{x}}=100$) (on *J. thomasi* Ten. from Bulgaria, Denchev 1991, 2001).

Variety *tenuis* differs from var. *caspariana* especially by the shorter spores and sori. On the base of the known data, and also according to our investigation, the sori of *E. caspariana* on hosts other than *Juncus tenuis*, are up to 15 mm in length, whereas those on *J. tenuis* are only up to 3 mm long. The spores of var. *tenuis* are $11.5-20 (-21.5) \times 10.5-20 (-21.5) \mu\text{m}$ (including the ornamentations) while these of var. *caspariana* are $(12-) 13.5-23 (-28) \mu\text{m}$ long. Variety *tenuis* differs from *Entorrhiza casparianella* Vánky by having tuberculate or verrucose spore ornamentation, with coarse tubercles or warts whereas the spores of *E. casparianella* have a smooth or undulate outer wall layer (cfr Vánky 1998: 342-343).

Four species of *Entorrhiza* are known on *Juncus*: *E. aschersoniana* (Magnus) Lagerh., *E. caricicola* Ferd. & Winge, *E. caspariana*, and *E. casparianella* (Fineran 1978, Vánky 1994, 1998).

Key to the known *Entorrhiza* taxa on *Juncus*

- 1 Spores mainly broadly ellipsoidal, ellipsoidal or ovoid, occasionally subglobose, $L/w > 1.06$ 2
- 1* Spores globose or subglobose, $L/w < 1.06$ 3
- 2 Spore wall rugulose-undulate or smooth *E. caricicola*
- 2* Spore wall verrucose *E. aschersoniana*
- 3 Outer wall layer smooth or undulate; spores $10-17 \mu\text{m}$ long *E. casparianella*
- 3* Outer wall layer coarsely tuberculate or verrucose, occasionally smooth 4
- 4 Spores $(12-) 13.5-23 (-28) \mu\text{m}$ long, sori up to 15 mm long *E. caspariana* var. *caspariana*
- 4* Spores $11.5-20 \mu\text{m}$ long, sori 1.2-3 mm long *E. caspariana* var. *tenuis*

Acknowledgements

We gratefully acknowledge Dr Royall T. Moore (University of Ulster, Coleraine, Northern Ireland, UK), Dr Roger G. Shivas (Queensland Department of Primary Industries and Fisheries, Australia), and Dr Eric H.C. McKenzie (Landcare Research, Auckland, New Zealand) for critically reading the manuscript and serving as pre-submission reviewers. The senior author thanks Mr Y.J. Choi and Mr J.G. Han (College of Life Sciences and Biotechnology, Korea University, Seoul) for their assistance during the field investigations in Korea. This work was supported by the Korea Research Foundation and the Korean Federation of Science and Technology Societies Grant funded by Korea Government (MOEHRD, Basic Research Promotion Fund).

Literature Cited

- Azbukina ZM, Karatygin IV. 1995. Ordo *Ustilaginales*. 1-263 + Pls 35-58, in V.A. Melnik (ed.), *Definitorium fungorum Rossiae*, Fasc. 2. Nauka, Petropoli. (In Russian)

- Denchev CM. 1991. New records of Bulgarian smut fungi (*Ustilaginales*). *Sydowia* 43: 15-22.
- Denchev CM. 2001. Classis *Ustomycetes* (Ordines *Tilletiales*, *Ustilaginales* et *Graphiolales*). 1-286, in V. Fakirova (ed.), *Fungi Bulgariae* 4. Editio Academica "Prof. Marin Drinov" & Editio Pensoft, Sofia. (In Bulgarian with an English summary)
- Denchev CM. 2004. Occurrence of *Entorrhiza casparyana* (*Ustilaginomycetes*) in Austria. *Mycologia Balcanica* 1: 49-50.
- Fineran JM. 1971. *Entorrhiza* C. Weber (*Ustilaginales*) in root nodules of *Juncus* and *Scirpus* in New Zealand. *New Zealand Journal of Botany* 9: 494-503.
- Fineran JM. 1978. A taxonomic revision of the genus *Entorrhiza* C. Weber (*Ustilaginales*). *Nova Hedwigia* 30: 1-68.
- Fineran JM. 1982. Teliospore germination of *Entorrhiza casparyana* (*Ustilaginales*). *Canadian Journal of Botany* 60: 2903-2913.
- Piepenbring M. 2003. Smut fungi (*Ustilaginomycetes* p.p. and *Microbotryales*, *Basidiomycota*). *Flora Neotropica*, Monograph 86. The New York Botanical Garden Press, Bronx, NY.
- Scholz H, Scholz I. 1988. Die Brandpilze Deutschlands (*Ustilaginales*). *Englera* 8: 1-691.
- Ványk K. 1985. Carpathian *Ustilaginales*. *Symbolae Botanicae Upsalienses* 24(2): 1-309.
- Ványk K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York.
- Ványk, K. 1998. New Australasian *Ustilaginales*. *Mycotaxon* 68: 327-344.
- Ványk K. 2002. Illustrated genera of smut fungi. 2nd edn. APS Press, St. Paul, Minnesota, USA.
- Ványk K, McKenzie EHC. 2002. Smut fungi of New Zealand. *Fungi of New Zealand*. Vol. 2. Fungal Diversity Press, Hong Kong.
- Wang SR, Piepenbring M. 2002. New species and new records of smut fungi from China. *Mycological Progress* 1: 399-408.
- Zundel GL. 1953. The *Ustilaginales* of the world. Contributions from the Department of Botany, School of Agriculture, The Pennsylvania State College 176: XI + 1-410.

A new record of *Bauhinus piperi* (Microbotryales) from Pakistan

MUHAMMAD ASIM SULTAN¹, CVETOMIR M. DENCHEV^{2*},
IKRAM-UL-HAQ¹ & A.N. KHALID³

asim418@yahoo.com

¹Department of Botany, Government College University
Lahore, Pakistan

cmdenchev@yahoo.co.uk

²Institute of Botany, Bulgarian Academy of Sciences
23 Acad. G. Bonchev St., 1113 Sofia, Bulgaria

³Department of Botany, University of the Punjab
Lahore, Pakistan

Abstract—A new record of *Bauhinus piperi* is reported from the Northern Areas of Pakistan on *Aconogonon rumicifolium* var. *rumicifolium*.

Key words—*Microbotryum*, smut fungi

Introduction

During a collecting trip for parasitic fungi in the Fairy Meadows locality, in the Northern Areas of Pakistan, carried out by the senior author, leaves of *Aconogonon rumicifolium* were found infected with a smut fungus.

The Northern Areas of Pakistan are well known for their rich biodiversity, including about 3000 plant species. Most parts of the Northern Areas lie within the watershed of the Himalayas, Hindukush, and Karakoram Mountain ranges. The main watershed runs southwards, draining into the river Indus. Climatic conditions vary widely ranging from the monsoon-influenced moist temperate zone in the western Himalaya, to the arid and semi-arid cold desert in the Northern Karakoram and Hindukush (Sugong 1990, Anonymous 1994). Fairy Meadows, situated at an altitude of 3300 m, is thickly wooded with birch trees, firs and dwarf pines that spread up to snow line at 3600 meters.

*Author for correspondence

Material and methods

Dried herbarium material was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean $\pm$ 1 standard deviation). For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum-palladium with a Hitachi E-1030 ion sputter. The surface structure of spores was observed at 20 kV and photographed with a Hitachi S-4200 scanning electron microscope.

New record

The collected specimen belongs to *Bauhinus piperi*. It is a new record for Pakistan (cfr Ahmed et. al. 1997).

Bauhinus piperi (G.P. Clinton) Denchev, Mycotaxon 65: 424, 1997. **FIGS 1-2**

= *Ustilago piperi* G.P. Clinton, Proc. Boston Soc. Nat. Hist. 31: 382, 1904. = *Microbotryum piperi* (G.P. Clinton) Vánky, Mycotaxon 67: 48, 1998.

= *Sphacelotheca polygoni-alpini* P. Cruchet, Bull. Herb. Boissier, Ser. 2, 7: 247, 1908. = *Ustilago polygoni-alpini* (P. Cruchet) Zundel, Mycologia 43: 267, 1951.

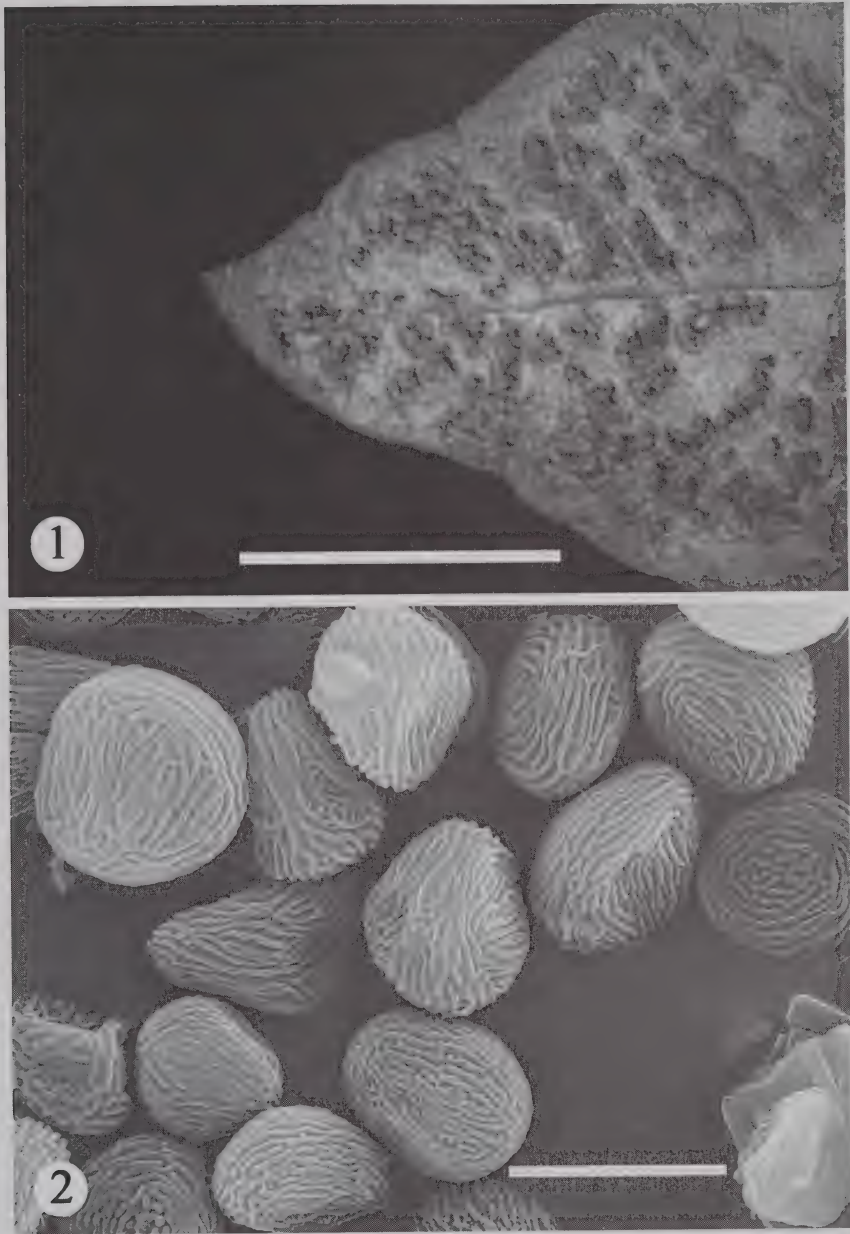
= *Ustilago sinkiangensis* Y.C. Wang, Acta Bot. Sinica 10: 134, 1962.

Sori on leaves, hypophyllous, forming pustules, limited by the veins, rounded, elongated or irregular, 0.3-2 mm long, later many of them more or less confluent, elongated or irregular and up to 5 mm in length, not situated along the margin; covered by the epidermis which ruptures irregularly disclosing the spore mass. **Spore mass** middle to dark reddish brown. **Spores** mainly globose, subglobose, broadly ellipsoidal or ovoid, rarely irregular or ellipsoidal, $6-11 \times 5.5-9 \mu\text{m}$ ($8.1 \pm 1.1 \times 7.3 \pm 0.9 \mu\text{m}$ ($n=50$)), light purplish brown; spore wall in LM striate, in SEM with dense, curved, parallel or ramified, anastomosing striae.

SPECIMEN EXAMINED — On leaves of *Aconogonon rumicifolium* (Royle ex Bab.) H. Hara var. *rumicifolium* (*Polygonum rumicifolium* Royle ex Bab.) (det. S.P. Hong). **PAKISTAN:** Northern Areas, FAIRY MEADOWS, alt. 3300 m, 21 August 2001, coll. M.A. Sultan, AS # 47 (SHI).

Comments— Vánky (1998) transferred this species from *Ustilago* to *Microbotryum*. Recently, it was demonstrated that the genus *Microbotryum* should be reduced only to the group of the anthericolous species (incl. *M. majus*) on *Caryophyllaceae* (Almaraz et al. 2002, Denchev et al. 2006, 2007, Kemler et al. 2006) while the former *Ustilago* species on *Polygonaceae* have been transferred to *Bauhinus* (Denchev 1997, Denchev et al. 2006, 2007).

Bauhinus piperi has previously been reported from Europe, Central Asia (Uzbekistan, Nepal, and China), East Asia (Far East of Russia), and North



Figs. 1-2. *Bauhinus piperi* on *Aconogonon rumicifolium* var. *rumicifolium*: 1. Sori on the abaxial side of a leaf; 2. Spores in SEM. Scale bars: 1 = 1 cm, 2 = 7.5 μ m.

America (U.S.A.) (Clinton 1904, Balfour-Browne 1968, Vánky 1994, Vánky & Oberwinkler 1994, Azbukina et al. 1995, Guo 2000). *B. piperi* is known only on plants of the genus *Aconogonon* (*A. alpinum* (All.) Schur, *A. davisiae* (W.H. Brewer ex A. Gray) Soják, *A. phytolaccifolium* (Meisn. ex Small) Small, *A. rumicifolium*, *A. songoricum* (Schrenk) H. Hara, *A. tripterocarpum* (A. Gray) H. Hara). It is the second record of *Bauhinus piperi* on *Aconogonon rumicifolium* which has been previously recorded from Nepal (Balfour-Browne 1968). *Aconogonon rumicifolium* is a biennial-perennial herbaceous plant found in Pakistan at altitudes from 3000-4500 m and distributed also in Afghanistan, Nepal, and Tibet (Quaiser 2006)

Acknowledgements

We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany) and Dr Roger G. Shivas (Queensland Department of Primary Industries and Fisheries, Australia) for reading the manuscript and serving as pre-submission reviewers; Prof. Makoto Kakishima (University of Tsukuba, Japan) for the opportunity to prepare SEM photographs in his laboratory; Prof. Suk-Pyo Hong (Kyunghee University, Seoul, Korea) for identification of the host plant.

Literature cited

- Ahmed S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Sultan Ahmed Mycological Society of Pakistan, Department of Botany, University of Punjab, Lahore, Pakistan.
- Almaraz T, Roux Ch, Maumont S, Durrieu G. 2002. Phylogenetic relationships among smut fungi parasitizing dicotyledons based on ITS sequence analysis. *Mycological Research* 106: 541-548.
- Anonymous. 1994. Declaration of some Wilderness Areas as National Park in Northern Areas, Islamabad, Kashmir Affairs, and Northern Areas Affairs Division. Government of Pakistan.
- Azbukina ZM, Karatygin IV, Govorova, OK. 1995. Class 1. *Ustomycetes* Moore. 9-205, in ZM Azbukina (ed.), *Plantae non vasculares, Fungi et Bryopsida orientis extremi rossica*, Fungi, 3. Petropoli, Nauka. (In Russian)
- Balfour-Browne F.L. 1968. Fungi of recent Nepal expeditions. *Bull. Brit. Mus. (Nat. Hist.), Bot.* 4(3): 99-141.
- Clinton GP. 1904. North American *Ustilagineae*. *Proceedings of the Boston Society of Natural History* 31: 329-529.
- Denchev CM. 1997. New combinations in *Bauhinus* (*Microbotryaceae*). *Mycotaxon* 65: 419-426.
- Denchev CM, Moore RT, Shin HD. 2006. A reappraisal of the genus *Bauhinus* (*Microbotryaceae*). *Mycologia Balcanica* 3: 71-75.
- Denchev CM, Kakishima M, Shin HD, Lee SK. 2007. Notes on some Japanese smut fungi. III. *Ustilago moehringiae*. *Mycotaxon* 98[2006]: 181-184.
- Guo L. 2000. *Flora Fungorum Sinicorum*. Vol. 12. *Ustilaginaceae*. Beijing, Science Press. (In Chinese)
- Kemler M, Göker M, Oberwinkler F, Begerow D. 2006. Implications of molecular characters for the phylogeny of the *Microbotryaceae* (*Basidiomycota: Urediniomycetes*). *BMC Evolutionary Biology* 6. [<http://www.biomedcentral.com/1471-2148/6/35> (viewed on line on 9 May 2006)]

- Quaiser M. 2006. *Polygonaceae* A.L. Jussieu, in Flora of Pakistan, vol. 205 [http://www.efloras.org/florataxon.aspx?flora_id=58&taxon_id=242100004 (viewed on line on 9 Dec 2006)].
- Sugong WU. 1990. General characteristics of flora of the Karakorum-Kunlun Mts. and Conservation, Exploitation, and Utilization of the plant resources. *Journal of Natural Resources* 5(4): 376-382.
- Vánky K. 1994. European smut fungi. Stuttgart, Jena, New York, Gustav Fischer Verlag.
- Vánky K. 1998. The genus *Microbotryum* (smut fungi). *Mycotaxon* 67: 33-60.
- Vánky K, Oberwinkler F. 1994. *Ustilaginales* on *Polygonaceae*, a taxonomic revision. *Nova Hedwigia*, Beiheft 107: 1-96.

**Rhizomorph anatomy confirms the taxonomic position of
Sclerogaster (Phallomycetidae, Basidiomycota)**H. CLÉMENÇON¹, K. HOSAKA² & A.F.S. TAYLOR³

heinz.clemencon@bluewin.ch

¹Musée Botanique Cantonal

Avenue de Cour 14bis, CH-1007 Lausanne, Switzerland

²Department of Botany, The Field Museum

1400 S Lake Shore Dr, Chicago, IL, USA

³Department of Forest Mycology and Pathology

Swedish University of Agricultural Sciences

P.O. Box 7026, Ulls väg 26a, SE 750 07 Uppsala, Sweden

Abstract—The anatomy of the rhizomorphs of the hypogeous gasteroid basidiomycete *Sclerogaster compactus* is described. Its molecular taxonomic position in the gomphoid-phalloid clade is confirmed on morphological grounds.

Key words—gastromycetes, taxonomy, systematics

The hypogeous gasteroid genus *Sclerogaster* Hesse (1891) was placed by its author in the «Hymenogastreen», an artificial assembly of truffle-like basidiomycetes characterized by a spongy gleba composed of innumerable small cavities lined with a hymenium. According to Hesse, *Sclerogaster* differs from the other genera of the «basidiomycete truffles» by its ochre yellow, spherical, warted spores and the copious development of a white «mycelium» surrounding the basidiomes and extending far into the substrate. Actually, the «mycelium» is formed by many white rhizomorphs.

Fischer (1900) placed *Sclerogaster* in the family *Hymenogastraceae* and stated that *Hymenogaster* shows developmental similarities with the *Phallaceae*, but he did not venture any phylogenetic conclusions. Early phylogenetic speculations placed *Sclerogaster* in the «série des Astérosporés» (i.e. the *Russulales*) leading from the agaricoid *Russula* and *Lactarius* to gasteroid fungi like *Macowanites*, *Hydnagnium* and *Gymnomyces*, and finally to *Sclerogaster* (Malençon 1931). This speculation was accepted by Gäumann (1964) and Heim (1971) but rejected by Singer (1959) and Singer & Smith (1960). More recent schemes tentatively placed *Sclerogaster* in the *Boletales* (Kirk & al. 2001; Watling 2006), but analyses

of DNA sequence data now place it in the *Geastrales* of the gomphoid-phalloid clade (Hosaka 2005; Hosaka & al. 2007).

Rhizomorph anatomy can contribute significantly to the understanding of the phylogeny and systematics of the basidiomycetes, often confirming phylogenetic classifications proposed by studies using DNA sequence data (e.g. Agerer 1999, 2002; Agerer & Iosifidou 2004; Cléménçon 2004a). Several different developmental and architectural rhizomorph types are distinguished by Agerer (1999), which depend on the presence and distribution of vessel-like hyphae, ampullate swellings at the septa, fibre hyphae, secretory hyphae and backward growing hyphae. The rhizomorphs of the earth star genera *Geastrum* and *Myriostoma* (*Geastrales*) of the gomphoid-phalloid clade are characterized by the presence of «trumpet-like hyphae» with ampullate swellings at the septa, dextrinoid fibre hyphae, secretory hyphae with a yellow, granular content and short, lateral, peglike ramifications («oleoacanthohyphae»), and «yellow globular cells» with the same content (Agerer & Beenken 1998; Agerer & Iosifidou 2004, their fig. 25). This architecture is here called «geastroid». Since DNA-based analyses placed *Sclerogaster* in the *Geastrales* (Hosaka 2005; Hosaka & al. 2007), the rhizomorph anatomy of that genus is expected to be geastroid, too.

In July 2006 a large collection of *Sclerogaster compactus* (Tul. & C. Tul.) Sacc. made in Switzerland enabled a study of the anatomy of its conspicuous rhizomorphs. The results support the placement of the genus *Sclerogaster* in the *Geastrales*, as proposed by Hosaka (2005) and Hosaka & al. (2007) based on DNA sequence data analyses.

Material and methods

Basidiomes of *Sclerogaster compactus* (Tul. & C. Tul.) Sacc. with attached rhizomorphs were collected by G. Martinelli at Künten AG, Switzerland, in a small, humid depression in a mixed forest and brought to the WSL (Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft) in Birmensdorf, Switzerland. Beatrice Senn-Irlet and F. Ayer of the WSL identified the fungus that is now incorporated in the WSL collection under the accession number BSI 06/78. Part of this collection is also stored in the Botanical Museum in Lausanne, Switzerland (LAU), accession number HC 06/009.

Fresh rhizomorphs were fixed with a cold, buffered aldehyde solution, dehydrated with methyl cellosolve and embedded in a methacrylate mixtures, and the microtome sections stained with aluminum-zirconium haematoxylin as described by Cléménçon (2000). Other sections were stained with iron chloride - haematoxylin - copper sulphate: 1) Iron-III-chloride 1% in distilled water, 1-2 h; 2) rinse in two charges of distilled water for about 5 min. each; 3) stain with a ripened solution of 0.1% haematoxylin in distilled water for about 1

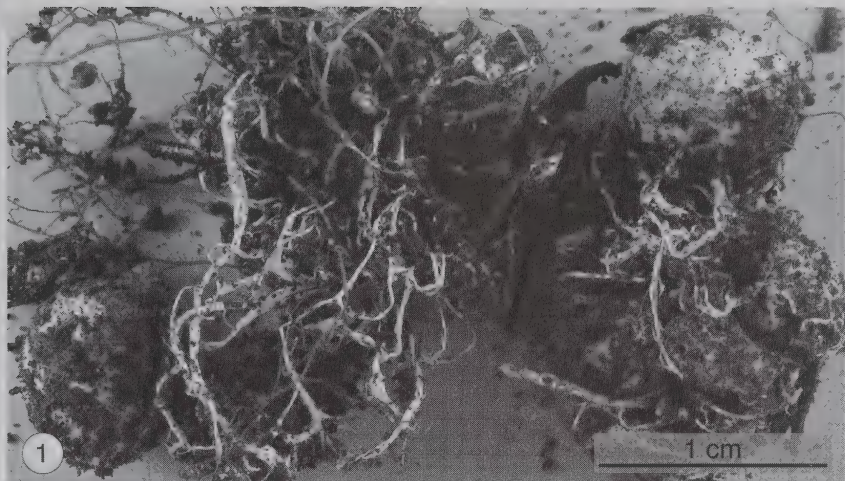


Figure 1. Basidiomes (at the extreme lower left and upper right margins) and white rhizomorphs of *Sclerogaster compactus*, coll. HC 06/009 (LAU).

h; 4) rinse in two charges of distilled water for about 5 min. each; 5) stabilise the staining result with a 1% solution of copper sulphate in distilled water for about 15 min. 6) rinse in distilled water for about 10-15 min., air dry the sections on a hot bench of about 65-70°C and mount in Entellan (Merck). Do not use the more popular ammonium iron sulphate instead of the iron chloride, as the hyphal walls do not stain after this mordant. Nuclei were stained with iron-aceto carmine using the procedure outlined by Cléménçon (1986). Squash mounts of rhizomorph fragments were also stained with cotton blue 0.2% in concentrated lactic acid, toluidine blue O 0.01% in 20% glycerol, patent blue V 1% in distilled water, and with 1% Congo red with 1% SDS in distilled water (Cléménçon 1998).

Results

The rhizomorphs of *Sclerogaster compactus* are chalk white, dry, profusely ramified and irregularly rounded in cross section (figs. 1,4). Their thickness ranges from about 50 µm to almost 1 mm. A cortex of rather complex anatomy surrounds a medulla of simpler architecture (figs. 2,3). No part of the rhizomorph is gelatinous.

The **cortex** is built from six elements: A coating of thick-walled, dextrinoid fibre hyphae; crystal aggregates; patches of amorphous or partly birefringent masses; secretory hyphae with a pale yellow, granular content; droplets derived from the secretory hyphae; and small chunks of a brown pigment.

The fibre hyphae of the cortex are cylindrical but sometimes strongly curved and often have a slightly uneven surface. The walls are dextrinoid and more or

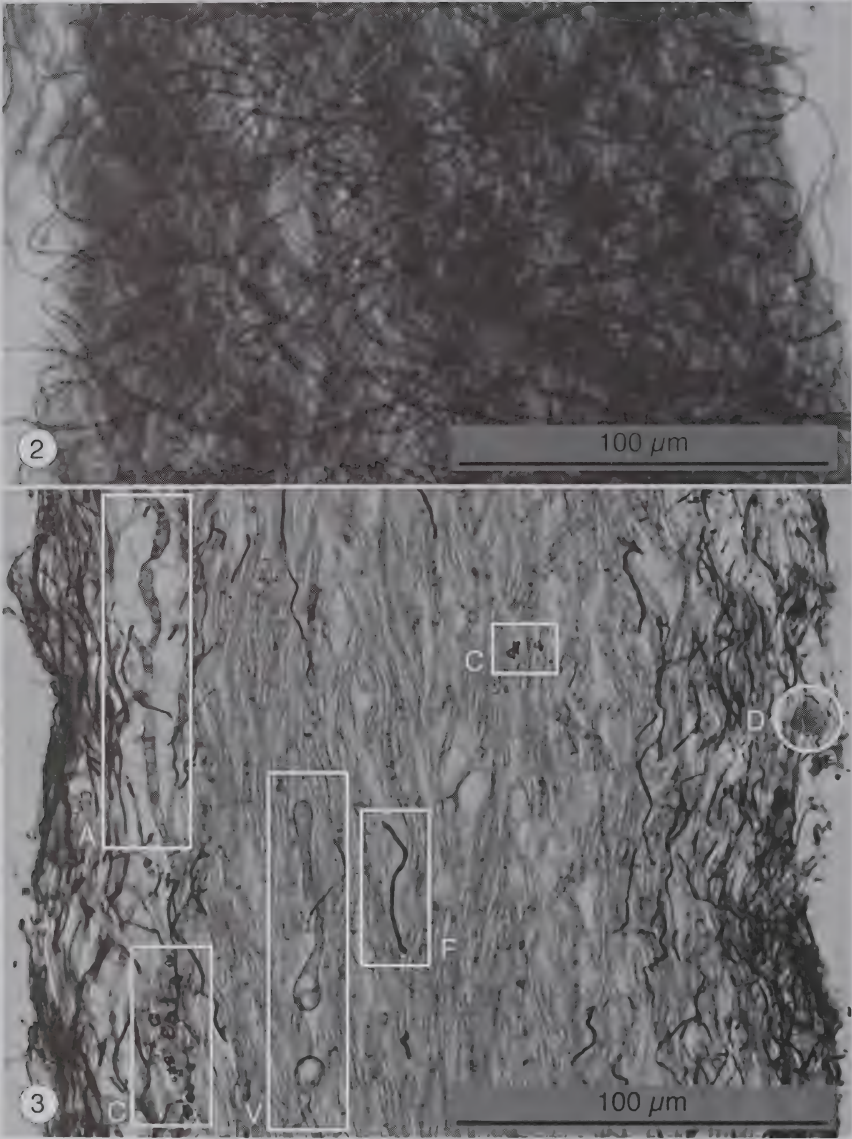


Figure 2. Superficial dextrinoid fibre hyphae mounted in Melzer’s iodine solution.

Figure 3. Longitudinal section of a rhizomorph. A: Amorphous masses with central thin-walled hypha. C: Crystal aggregates. D: A droplet formed by the content of a gloeoplerous hypha. E: A fibre hypha located within the medulla (most fibre hyphae are located near the surface of the cortex). V: Vesicles formed by ampullate swellings.

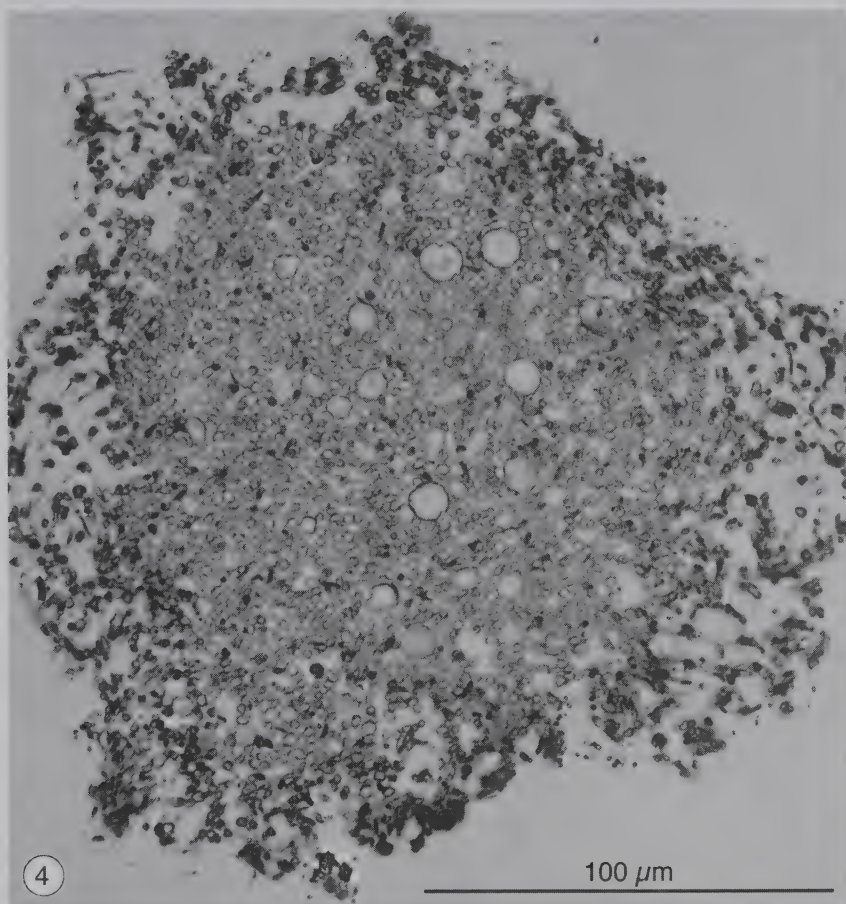
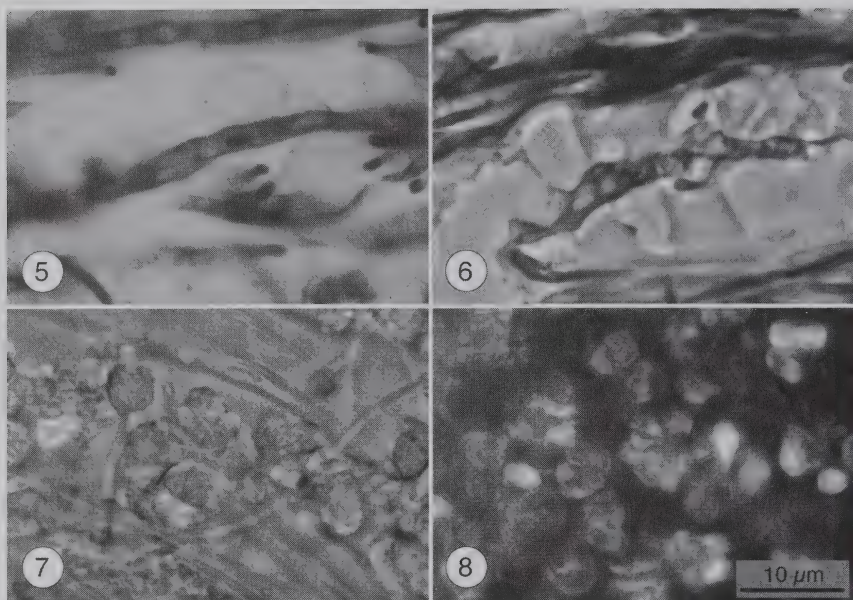


Figure 4. Cross section of a rhizomorph. The fibre hyphae appear very dark; most are located in the surface coating, but some also occur in the medulla. The large cross sections in the medulla are not tubular hyphae but ampullate swellings of generative hyphae.

less cyanophilous. They stain strongly with Congo red and lilac with toluidine blue. The diameter of the fibre hyphae and the thickness of their walls decrease slightly from the outside to the inside of the coating, from about 1-1.8 μm to 0.6-1 μm , and from 0.3-0.6 μm to 0.1-0.4 μm , respectively. Correspondingly, the strength of the dextrinoid reaction decreases slightly from the outside to the inside of the coating, while the cyanophily of the walls decreases greatly. A few dextrinoid fibre hyphae are evenly scattered throughout the medulla (figs. 3,4).

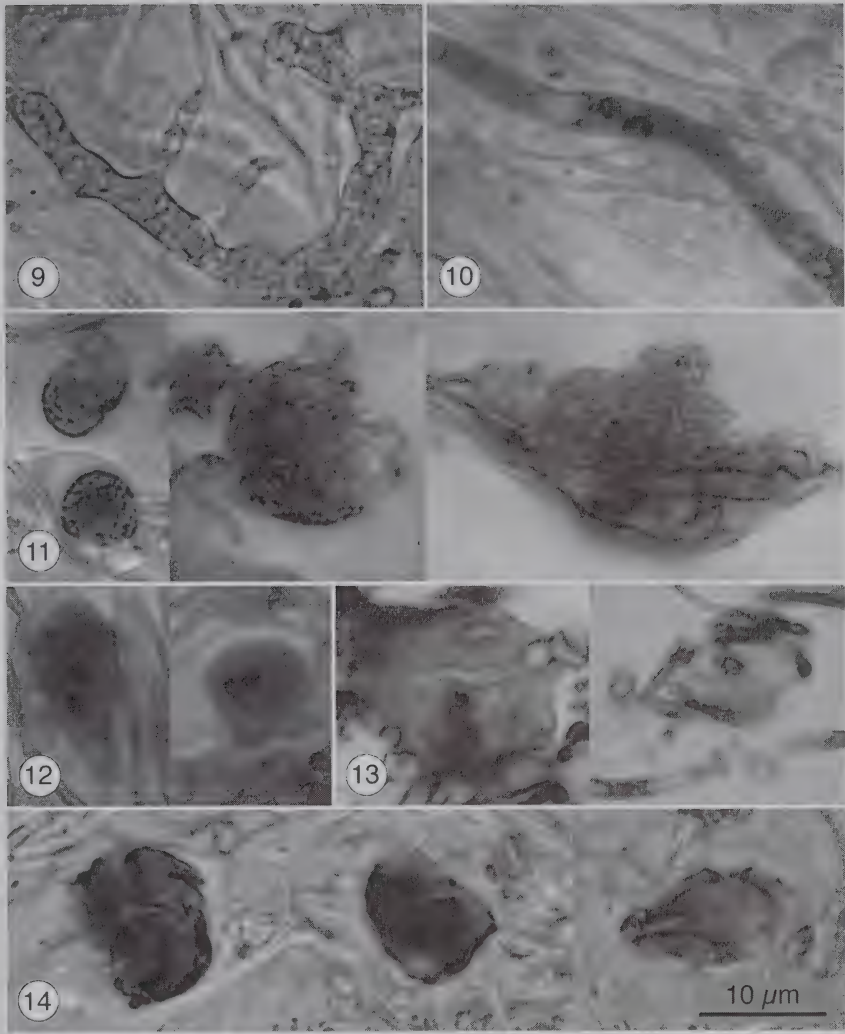


Figures 5-8. Amorphous to partly birefringent masses in the cortex. 5,6: Central hyphae surrounded by the masses viewed in bright field (5) and phase contrast (6); longitudinal sections. The originally cylindrical hyphae became more or less deformed by the masses. A nucleus is visible in the figure 5. 7-8: Partly birefringent masses in squash preparations viewed in bright field (7) and in polarised light (8).
- Scale valid for all photographs.

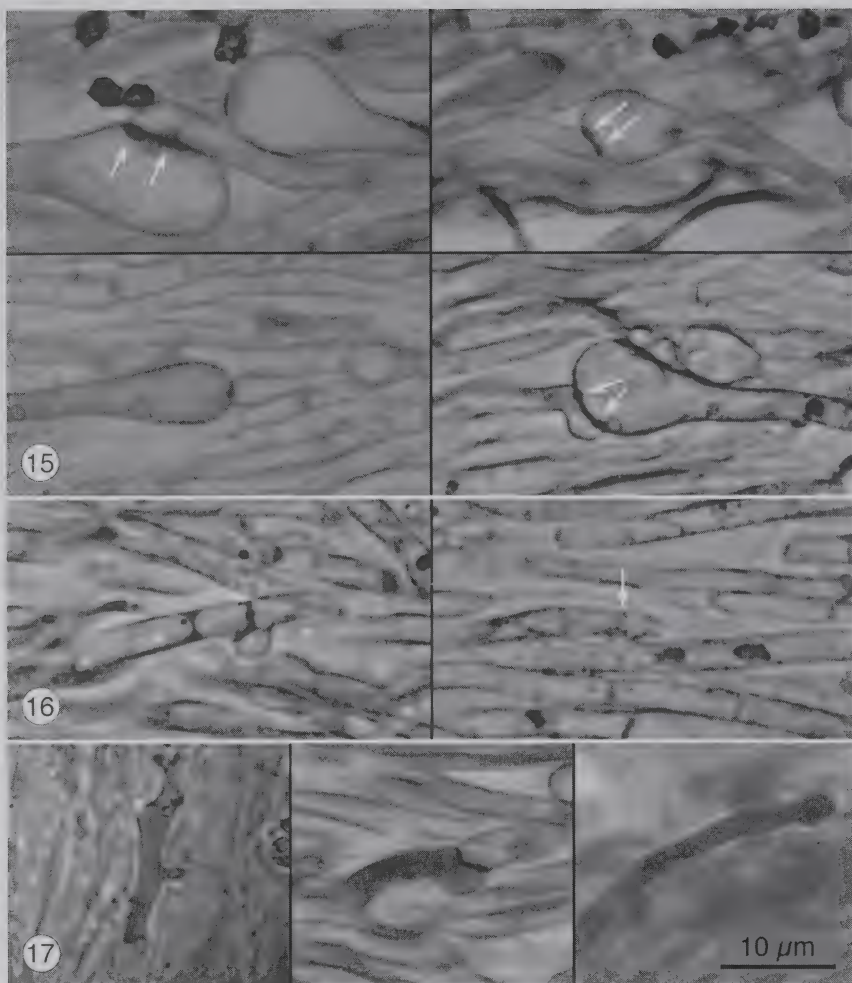
Crystal aggregates of different sizes are scattered on the surface of the rhizomorph, more rarely in deeper layers of the cortex or in the medulla (fig. 3: rectangles C).

In the deeper layers of the surface coating and just beneath it occur patches of amorphous or partly birefringent masses of unknown nature. They are easily visible in squash mounts but more difficult to see in serial sections of embedded material (fig. 3: rectangle A; figs. 5-8). In the center of the patches we find a single, wide, thin-walled hypha with nuclei and clamp connections. They are cylindrical or may become deformed by the masses surrounding them.

Secretory hyphae with a pale yellow, granular deuteroplasm (Clémenton 2004b) are located below and within the cortex (fig. 9). Short lateral pegs occur frequently and are reminiscent of «oleoacanthohyphae» (Agerer & Iosifidou 2004). Since nuclei are present (fig. 10), they are living gloeoplerous hyphae in the sense of Clémenton (2004b). The deuteroplasm is not altered by organic solvents and probably does not contain oils, so «oleoacanthohyphae» may be a misnomer. Some gloeoplerous hyphae produce terminal swellings that stretch the cell wall until rupture occurs, releasing the deuteroplasm (fig. 11).



Figures 9-14. Gloeoplerous hyphae, gloeoplerous droplets and brown pigment masses from the cortex of a rhizomorph, squash preparations. **9:** Unstained gloeoplerous hypha with short lateral ramifications («oleoacanthohypha»); **10:** A binucleate gloeoplerous hypha, iron acetocarmine. **11:** Formation of gloeoplerous droplets from gloeoplerous hyphae. At left two young terminal vesicles still with an intact cell walls. The middle photograph shows an burst swelling with a thinned out, broken cell wall to the left, exposing the naked deuterooplasm towards the right. The right photograph shows the naked deuterooplasm flowing along thin hyphae and around a thicker one. Congo red. **12:** Two binucleate droplets; iron acetocarmine. **13:** Two naked droplets flowing around hyphae. Tannin-iron-haematoxylin. **14:** Brown pigment masses, the right most one showing remains of a hypha.
- Scale valid for all photographs.



Figures 15-17. The medulla in longitudinal sections; aluminum-zirconium haematoxylin. **15:** Ampullate swellings. The white arrows indicate dolipore junctions. **16:** A clamp connection (left) and an H-connection (white arrow). **17:** Thromboplerous hyphal segments. The left most photograph shows an adjacent gloeoplerous segment on its top. - Scale valid for all photographs.

Free gloeoplerous droplets frequently contain nuclei (fig. 12) and often flow around neighbouring hyphae (figs. 11,13).

Near the surface of the cortex free, small chunks of a brown, brittle mass are scattered between the fibre hyphae. Some look as if they still contain remains of the hypha that secreted the pigmented mass (fig. 14).

The **medulla** consists mainly of more or less longitudinally oriented, slightly interwoven, thin-walled, cylindrical, binucleate, clamp bearing generative hyphae with ampullate inflations at many septa (figs. 3,15,16). Occasionally an H-connection occurs between two hyphae (fig. 16). A few dextrinoid fibre hyphae and some irregularly shaped crystals are scattered throughout the medulla (figs. 4, 15). Gloeoplerous hyphae are rare in the medulla, but thromboplerous segments of otherwise generative hyphae are occasionally seen (fig. 17). Wide tubular hyphae with reduced septa and octahedral crystals are lacking.

Discussion

The **unusual anatomical details** of the *Sclerogaster compactus* rhizomorphs are the naked drops of deuterooplasm and the amorphous or partly birefringent masses with a central hypha in the cortex. Together they may perhaps be characteristic of a sclerogasteroid type rhizomorph proper to the *Sclerogastraceae*, as opposed to the geastroid architecture of the *Geastraceae* lacking those structures, but more species from both families must be studied to confirm or reject this possibility.

The naked gloeoplerous droplets are reminiscent of the «globular yellow cells ... easily deformed from their very thin cell walls» of the ramarioid rhizomorph type D of Agerer & Iosifidou (2004), and the two structures may indeed be homologous. Dissolution of the cell wall of gloeoplerous hyphae may explain the isolated occurrence of the droplets far from any secretory hypha. Indeed, our observations suggest that secretory segments of a hypha could be transformed into a naked droplet by such a mechanism.

The amorphous or partly birefringent masses with a central hypha are difficult to interpret in terms of homologies. The masses may be secreted or excreted by the central hypha and remain amorphous for some time before partly crystallizing and becoming birefringent. The amorphous masses seem to be soluble in organic solvents, as they are frequently absent from microtome sections made from material passed through the alcohol series before embedding, leaving empty spaces clearly visible in phase contrast. However, the birefringent parts survive embedding and thus can be found in the microtome sections.

The **relevant phylogenetic structures** of the *Sclerogaster compactus* rhizomorphs are the ampullate septa, dextrinoid fibre hyphae, gloeoplerous, spine bearing hyphae (oleoacanthohyphae, Agerer & Iosifidou 2004), and the gloeoplerous droplets probably homologous with the «globular yellow cells». This combination is said to occur «typically in the genera *Geastrum* and its relative *Myriostoma*» (Agerer & Iosifidou 2004). These four structures indicate a phylogenetic relationship between the three genera, all three being now placed

in the *Gaeastrales*, *Phallomycetidae*, by analyses of DNA sequence data (Hosaka 2005; Hosaka & al. 2007).

So far peripheric dextrinoid fibre hyphae have been observed in the rhizomorphs of some species of three phylogenetically distinct but not closely related mushroom and puff ball groups: 1) *Agaricaceae* and *Lycoperdaceae* (*Agaricus*, *Lepiota*, *Cystolepiota*, *Macrolepiota*, *Chlorophyllum*; *Lycoperdon*, *Bovista*; Agerer 1999; personal observations by HC), 2) *Mycenaceae* (*Prunulus*; Cléménçon 2004a), and 3) *Ramariaceae*, *Gaeastraceae* and *Sclerogastraceae* (*Ramaria stricta*; *Gaeastrum*, *Myriostoma*, Agerer & Iosifidou 2004; and *Sclerogaster*). It is therefore possible that dextrinoid fibre hyphae are polyphyletic and that they have phylogenetic and taxonomic importance on a local scale only. However, their occurrence in *Sclerogaster* together with ampullate septal swellings of the medullar hyphae is a strong indication of the placement of this genus in the gomphoid-phalloid clade.

Secretory hyphae are widespread in rhizomorphs, but mostly in the form of thromboplerous hyphae (e.g. Cléménçon 2005, and further personal observations). Gloeoplerous hyphae are much more restricted and occur mainly in the gomphoid-phalloid clade (Agerer & Iosifidou 2004), thus confirming the placement of *Sclerogaster* in this phylogenetic unit.

Acknowledgments

We thank Beatrice Senn-Irlet and F. Ayer of the WSL (Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft) and G. Martinelli (Zürich, Switzerland) for identifying and making available a rich collection of the fungus studied. We are grateful to D. Hibbett, Biology Department, Clark University, Worcester, MA, USA, and to R. Agerer, Ludwig-Maximilians-Universität, Munich, Germany, for reading, commenting and correcting our manuscript.

Literature cited

- Agerer R. 1999. Never change a functionally successful principle: The evolution of *Boletales* s.l. (Hymenomycetes, *Basidiomycota*) as seen from below-ground features. *Sendtnera* 6: 5–91.
- Agerer R. 2002. Rhizomorph structures confirm the relationship between *Lycoperdales* and *Agaricaceae* (Hymenomycetes, *Basidiomycota*). *Nova Hedwigia* 75: 367–385.
- Agerer R, Beenken L. 1998. *Gaeastrum fimbriatum* Fr. + *Fagus sylvatica* L. *Descr. Ectomyc.* 3: 13–18.
- Agerer R, Iosifidou P. 2004. Rhizomorph structures of Hymenomycetes: A possibility to test DNA-based phylogenetic hypotheses? In: Agerer & al. (eds.): *Frontiers in Basidiomycote Mycology*, pp. 249–302. IHW-Verlag, Eching.
- Cléménçon H. 1986. Schwärzende *Lyophyllum*-Arten Europas. *Zeitschr. f. Mykologie* 52: 61–84.
- Cléménçon H. 1998. Observing the Dolipore with the Light Microscope. *Inoculum. Supplement to Mycologia* Vol. 49(2): 3.
- Cléménçon H. 2000. Mycelial morphology, mitospores and primordium formation of *Simocybe sumptuosa* in laboratory cultures. *Persoonia* 17: 407–433.

- Cléménçon H. 2004a. Les rhizomorphes de *Prunulus* (Basidiomycètes, *Tricholomatales*, *Mycenaceae*). Bull. soc. mycol. France 120: 25–35.
- Cléménçon H. 2004b. Cytology and Plectology of the Hymenomycetes. Bibliotheca Mycologica Volume 199. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart.
- Cléménçon H. 2005. Rhizomorph anatomy of *Ossicaulis lignatilis* (*Tricholomatales*), with special attention to its haustoria-like intrahyphal hyphae. Mycol. Progress 4: 167–173.
- Fischer E. 1900. Hymenogastrineae. In: Engler A & Prantl K (editors). Die natürlichen Pflanzenfamilien. I. Teil, Abteilung 1*, pp. 296–313. Engelmann Leipzig.
- Gäumann E. 1964. Die Pilze. Birkhäuser, Basel.
- Heim R. 1971. The interrelationships between the *Agaricales* and Gasteromycetes. In: Evolution of the Higher *Basidiomycetes*. Petersen RH (ed.), Univ. Tennessee Press, Knoxville.
- Hesse R. 1891. Die Hypogaeen Deutschlands. Band I, Die Hymenogastreen. Verlag Hofstetter, Halle a.S.
- Hosaka K. 2005. Systematics, phylogeny, and biogeography of the *Hysterangiales* and related taxa (*Phallomycetidae*, Homobasidiomycetes). PhD dissertation, Oregon State University, 386 pages.
- Hosaka K, Bates ST, Beever RE, Castellano MA, Colgan W, Domínguez LS, Nouhra ER, Geml J, Giachini AJ, Kenney SR, Simpson NB, Spatafora JW, Trappe JM. 2006. Molecular phylogenetics of the gomphoid-phalloid fungi with an establishment of the new subclass *Phallomycetidae* and two new orders. Mycologia 98: 949–959.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th edition. CABI Publishing, CAB International, Wallingford, Oxon UK.
- Malençon G. 1931. La série des Astérosporés. Trav. cryptogam. dédiés à L. Mangin. 1: 337–396.
- Singer R. 1959. Type studies in *Basidiomycetes* IX. Sydowia 13: 235–238.
- Singer R, Smith AH. 1960. Studies on the secotiaceous fungi IX. The astrogastraceous series. Mem. Torrey Bot. Club 21: 1–122.
- Watling R. 2006. The sclerodermatoid fungi. Mycoscience 47: 18–24.

**Notes on *Amphisphaeria*-like species in HMAS,
with a new combination:
Phaeodothis hainanensis (Pleosporales)**

YOU-ZHI WANG & WEN-HUA HE

yzwang@im.ac.cn

China General Microbiological Culture Collection Center
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China.

Abstract — Twenty-one specimens under various names of *Amphisphaeria*-like species in HMAS were re-examined. The taxa are repositioned according to modern taxonomic concepts. *Phaeodothis hainanensis* is treated here as a new combination based on *Amphisphaeria hainanensis*.

Key words — *Ascomycetes*, China, taxonomy

Introduction

Amphisphaeria Ces. & De Not. is a unitunicate pyrenomycete genus characterized by one-septate, brown ascospores. Since its establishment in 1863, several authors have contributed to research on *Amphisphaeria* (Aptroot 1995a, b; Barr 1984, 1989, 1994, 1996; Candoussau et al. 1986; Hawksworth 1985a, Hyde et al. 1996, Krug 1977, Müller & Arx 1962, Sivanesan 1975a, b; Teng 1936). Most recently, Wang et al. (2004) monographed the genus and accepted twelve species. Moreover, species excluded from *Amphisphaeria* are properly repositioned in the monograph.

Amphisphaeria has sometimes been used for many taxa with one-septate brown ascospores, however, the genus is only correctly employed for pyrenomycetes because the asci are unitunicate in structure and have an apical ring turning blue or not in iodine. The most similar genera are *Arecophila* K.D. Hyde, *Seynesia* Sacc., *Atrotriquata* Kohlm. & Volkm.-Kohlm., *Cainia* Arx & E. Müll., and *Roussoella* Sacc. (Wang et al. 2004).

There are also many extraneous bitunicate ascomycetous taxa having one-septate, brown ascospores that have been confused with *Amphisphaeria*,

such as *Astrosphaeriella*, *Byssosphaeria*, *Didymosphaeria*, *Dothidotthia*, *Kirschsteiniothelia*, *Lojkania*, *Montagnula*, *Mycomicrothelia*, and *Trematosphaeria*. However, these genera belong to loculoascomycetes, which are easily distinguished from *Amphisphaeria* by their bitunicate, J- asci (Wang et al. 2004).

Phaeodothis Syd. & P. Syd., which was recently reviewed by Aptroot (1995a), includes two species, *Phaeodothis ribesiella* (Nyl. ex Vain.) Aptroot and *P. winteri* (Niessl) Aptroot. Several *Didymosphaeria* species have been synonymized with these two species (Aptroot 1995a).

In China, nine *Amphisphaeria* species and seven *Didymosphaeria* species were recorded by Tai (1979). Unfortunately, not all the specimens are kept in the country. The study is based on dried herbarium specimens of *Amphisphaeria* and *Amphisphaeria*-like species deposited in the Herbarium Mycologicum Instituti Microbiologici Academiae Sinicae (HMAS). Chinese specimens outside the country, which have been studied by other authors, are also cited in this paper.

Taxonomy

Phaeodothis hainanensis (Teng) You Z. Wang, **comb. nov.**

Figs. 1-4.

MYCOBANK MB 510500

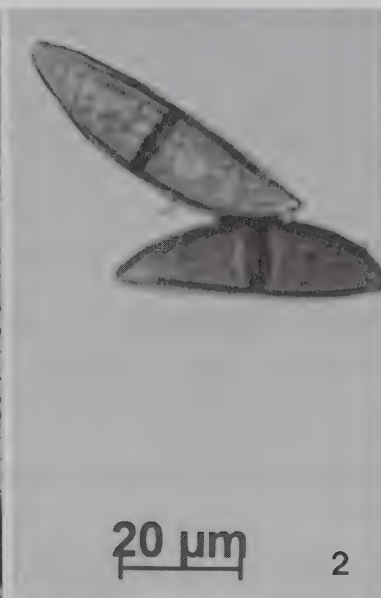
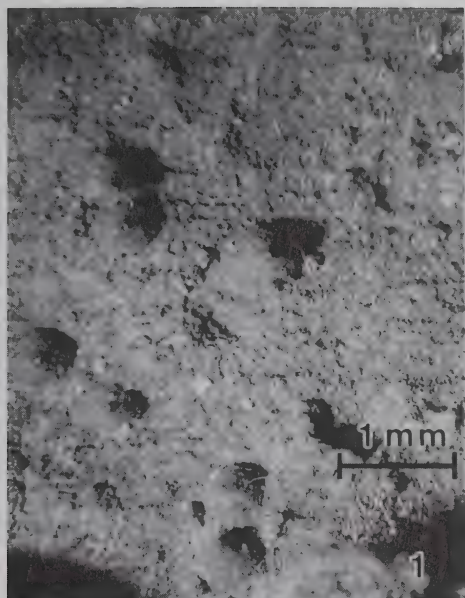
= *Amphisphaeria hainanensis* Teng, Sinensia 7: 508, 1936 (basonym).

Ascomata semi-immersed to erumpent or superficial, conoid, black, scattered to subgregarious, papillate, 750-800 μm wide. (Fig. 1). Pseudoparaphyses filamentous, persistent, septate, branched, ca 1 μm wide (Fig. 3). Asci cylindrical, pedicellate, 8-spored, portion with spores 270-280 $\times$ 20-25 μm , bitunicate, with ocular chamber. Ascospores 1-seriate to partly overlapping, 45-58 $\times$ 12-15 μm , broadly fusiform or lanceolate, with pointed ends, light to dark brown, 1-septate, asymmetrical, mostly slightly curved, and slightly constricted at the septum, smooth-walled (Figs. 2, 4).

Specimen examined: CHINA, Hainan, Lingshui, on decorticated wood. 24 May 1934, X.K. Teng 2346, det. S.H. Ou, HMAS 07210, Holotype of *Amphisphaeria hainanensis*.

Notes: The genus *Phaeodothis* is characterized by euseptate ascospores with a relatively broad, short and somewhat conical upper cell and a thinner, longer lower cell and by the sparse hamathecium consisting of thin pseudoparaphyses. *Phaeodothis hainanensis* differs from the two other species in the genus in having larger asci and ascospores.

Figs. 1-4. *Phaeodothis hainanensis* (from holotype of *Amphisphaeria hainanensis*). 1. Habit of ascomata on host surface. 2 & 4. Ascospores. 3. Pseudoparaphyses and ascospores.



Key to the species of *Phaeodothis*

- 1a. Ascospores $(11-13-16(-19) \times 4-6 \mu\text{m})$ *P. winteri*
 1b. Ascospores over $20 \mu\text{m}$ long 2
- 2a. Ascospores $20-25 \times 5-7 \mu\text{m}$, 1-3-septate, ascomata immersed *P. ribesiella*
 2b. Ascospores $45-58 \times 12-15 \mu\text{m}$, 1-septate, ascomata erumpent to superficial
 *P. hainanensis*

Other *Amphisphaeria*-like species in HMAS

Arecophila serrulata (Ellis & G. Martin) K.D. Hyde, Nova Hedwigia 63: 97. 1996.

Ascomata immersed, asci unitunicate, J+, ascospores striate, ca $25 \times 7.5 \mu\text{m}$.

Specimen examined: PHILIPPINES, December 1916, H.S. Yates 25598, HMAS 49488, as *Didymosphaeria striatula* Penz. & Sacc.

Notes: the specimen is in poor condition, and only a few ascospores could be found.

Astrosphaeriella stellata (Pat.) Sacc. Syll. Fung. 24: 938. 1928.

Specimens examined: CHINA, Guangxi, Longlin, Jinzhong Mountain, on decayed bamboo, 19 October 1957, L.W. Xu 95, det. S.C. Teng, HMAS 21872, as *Amphisphaeria fusispora* (Syd. & P. Syd.) Teng; CHINA, Guangxi, Longlin, Jinzhong Mountain, on decayed bamboo, 23 October 1957, L.W. Xu 275, det. S.C. Teng, HMAS 21873, as *A. fusispora*; CHINA, Hunan, Changsha, on bamboo culm, 11 September 1933, Q.Y. Shen, det. S.C. Teng, HMAS 07265, as *Amphisphaeria stellata* Pat.; CHINA, Fujian, Nanjing, on dead bamboo, 13 June 1958, S.C. Teng, det. S.C. Teng, HMAS 22603, as *A. stellata*; CHINA, Guizhou, Ceheng, Luxiong Lumbering Factory, on decayed bamboo, 2 November 1958, Q.Z. Wang 639, det. S.C. Teng, HMAS 26065, as *A. stellata*; CHINA, Hainan, Tan-hsien (Danxian), on decayed culm, 29 October 1934, S.C. Teng 5729, det. S.C. Teng, HMAS 06850, as *A. fusispora*.

Notes: There are three ascomyceteous fungi in the material of HMAS 06850. The first, with a rounded ostiole is *Astrosphaeriella stellata* (= *Amphisphaeria fusispora*) (Hawksworth 1981). Its ascomata are empty. The second, with a slit-like ostiole, is *Astrosphaeriella maculans* (Rehm) Aptroot et al. (Hyde et al. 2000). The third, with rounded ostiole and clypeus, is unknown because of empty ascomata. *Amphisphaeria stellata* was accepted as *Astrosphaeriella stellata* by Hawksworth (1981).

Didymosphaeria futilis (Berk. & Broome) Rehm, Hedwigia 18: 167, 1879.

Specimens examined: USA, Northville, S.D., on *Symphoricarpos occidentalis*, 20 February 1927, J.F. Brenckle, det. A. Aptroot, HMAS 02377, as *Didymosphaeria albescens* Niessl; USA, Northville, S.D., on *Polygonum emersum*, 20 May 1927, J.F. Brenckle, det. A. Aptroot, HMAS 02378, as *D. brunneola* Niessl; USA, Northville, S.D., on *Apocynum sibiricum*, 6 February 1927, J.F. Brenckle, det. A. Aptroot, HMAS 02379, as *D. brunneola*.

Notes: These materials were re-examined and redispersed most recently by Aptroot (1995b).

Didymosphaeria schizostachyi (Rehm) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 131. - Figs. 5-6.

Ascomata subglobose, semi-immersed or erumpent (Fig. 5). Peridium medium to dark brown, papilla short. Pseudoparaphyses $< 1 \mu\text{m}$, numerous, trabeculate in gelatinous matrix. Asci $104\text{--}120 \times 7\text{--}10 \mu\text{m}$, cylindrical, bitunicate, 1-seriate (Fig. 6). Ascospores $16\text{--}18 \times 5\text{--}6 \mu\text{m}$, ellipsoidal, medium brown, 2-celled, cells equal, without ornamentation, with a conspicuous median constriction and ends acute (Fig. 6).

Specimen examined: CHINA, Shaanxi, Qinling, on withered twigs, 4 August 2001, Y.Z. Wang, HMAS 99925.

Kirschsteiniothelia aethiops (Berk. & M.A. Curtis) D. Hawksw., Botanical Journal of the Linnean Society 91: 185. 1985. - Figs. 7-8.

Ascomata erumpent to superficial, hemispherical to subglobose, scattered, and slightly papillate (Fig. 7). Pseudoparaphyses, persistent, septate, branched, ca $2.5 \mu\text{m}$ wide. Asci $125\text{--}138 \times 20\text{--}23 \mu\text{m}$, 8-spored, cylindrical, bitunicate, with a small ocular chamber (Fig. 8). Ascospores $30\text{--}35 \times 10\text{--}12 \mu\text{m}$, 1-2 seriate, broadly fusiform, brown, 2-celled, and slightly constricted at the septum, smooth-walled, mostly inequilateral at the upper cell (Fig. 8).

Specimen examined: CHINA, Xinjiang, Urumqi, on *Clematis* sp., 24 May 1981, Z.Y. Zhao et al., det. Z.Y. Zhao, HMAS 89918 as *Didymosphaeria* sp.

Notes: *Kirschsteiniothelia aethiops* varies in ascospore sizes in different collections (Hawksworth 1985b). This collection has large ascospores, but within the range for *K. aethiops*.

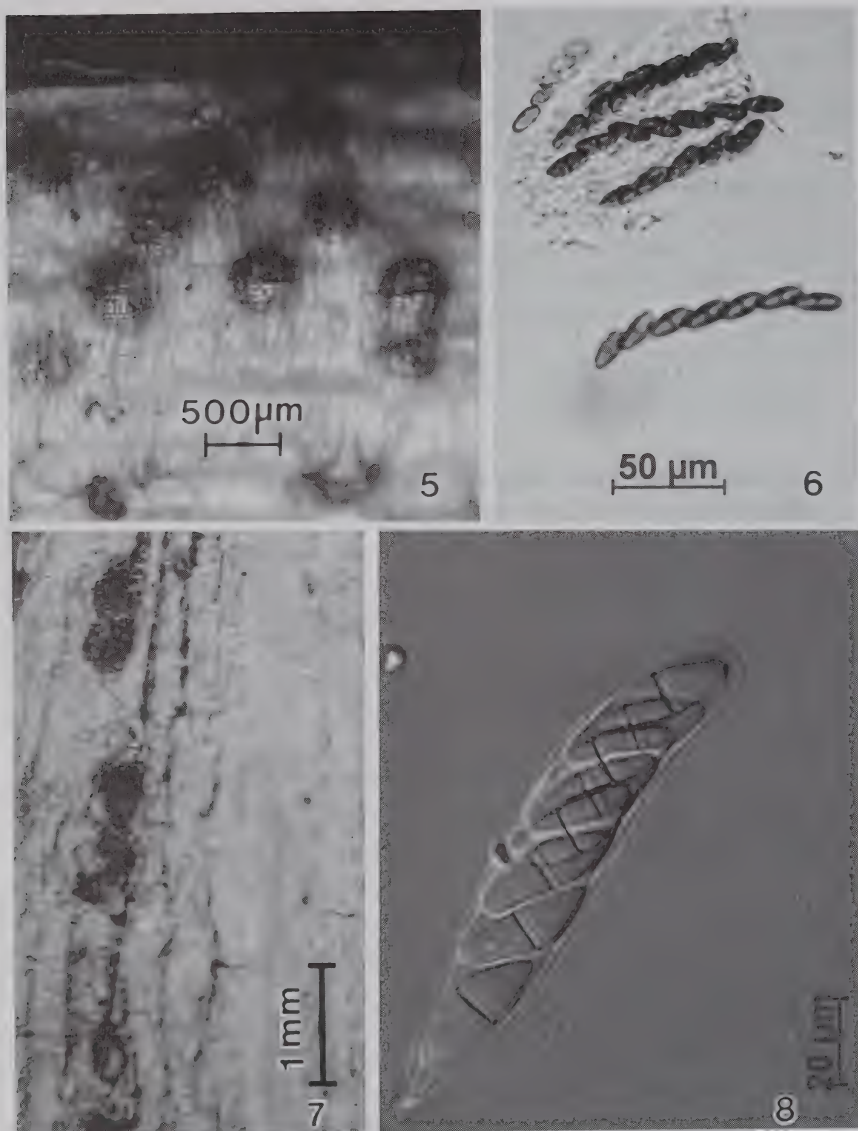
Kirschsteiniothelia populi (Tracy & Earle) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 123. 2004.

Specimen examined: CHINA, Gansu, Kilieshan (Qilian mountain), on decorticated limbs of *Populus*, 28 July 1945, S.C. Teng 4192, det. S.C. Teng, HMAS 07178, as *Amphisphaeria populi* Tracy & Earle.

Leptosphaerulina trifolii (Rostr.) Petrak, Sydowia 13: 76. 1959.

Specimens examined: PHILIPPINES, Los Banos, March 1920, on *Andropogon sorghum*, F. Gamboa, det. O.A. Reinking, HMAS 06652, HMAS 14027, as *Didymosphaeria anisomera* Sacc.

Notes: Aptroot (1995b) examined the isotype in HMAS, which he feels does not represent *Didymosphaeria*. The collector of the two HMAS collections (both in poor condition) may be different from the original collector of the *D. anisomera* holotype now curated in PAD.



Figs. 5-8. 5. *Dudmosphaeria schizostachyi*, habit of ascomata on host surface. 6. Asci and ascospores of *D. schizostachyi*. 7. *Kirschsteiniothelia aethiops*, habit of ascomata on host surface. 8. Asci and ascospores of *K. aethiops*.

Lojkania decorticata (Cooke & Harkn.) M.E. Barr, Mycotaxon 20: 14. 1984.

Specimen examined: CHINA, Xinjiang, Turpan (吐鲁番), on decayed twigs, 18 June 1958, L.W. Xu 27, det. S.C. Teng, HMAS 31229, as *Amphisphaeria decorticata* (Cooke & Harkn.) Berl. & Voglino.

Montagnula palmacea (Cooke) Aptroot, Nova Hedwigia 60: 341. 1995.

Specimens examined: PAKISTAN, Kalar kahar, on *Phoenix dactylifera*, 31 December 1975.
S. Ahmad 202126, HMAS 46169; S. Ahmad 25386, HMAS 59356, as *Didymosphaeria smaragdina* (Ces.) Sacc.

Notes: These two materials were re-examined and redispersed most recently by Aptroot (1995a).

Trematosphaeria insularis (S.H. Ou) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 95. 2004.

Specimens examined: CHINA, Hainan, Ting-an, 9 December 1934, S.C. Teng 7422, det. S.H. Ou. HMAS 07211, as *Amphisphaeria insularis* S.H. Ou; CHINA, Hainan, Danxian, 26 September 1934, X.K. Teng 4787, det. S.H. Ou, HMAS 07409, as *A. insularis*.

Notes: The material of HMAS 07211 is in poor condition.

Acknowledgements

Drs Eric McKenzie and André Aptroot are deeply thanked for pre-submission reviews. The authors would also like to thank Dr Gangrong Hu, the curator of HMAS, for loan of specimens. Thanks are extended to Dr Shaun Pennycook for nomenclatural review and Dr Lorelei Norvell (Editor-in-Chief of Mycotaxon) for final submission suggestions. This work was supported by the Funds of the Knowledge Innovation Program of the Chinese Academy of Sciences.

Literature cited

- Aptroot A. 1995a. Redisposition of some species excluded from *Didymosphaeria* (Ascomycotina). Nova Hedwigia 60: 325-379.
- Aptroot A. 1995b. A monograph of *Didymosphaeria*. Studies in Mycology 37: 1-160.
- Barr ME. 1984. *Herpotrichia* and its segregates. Mycotaxon 20: 1-38.
- Barr ME. 1989. Some unitunicate taxa excluded from *Didymosphaeria*. Studies in Mycology 31: 23-27.
- Barr ME. 1994. Notes on the *Amphisphaeriaceae* and related families. Mycotaxon 51: 191-224.
- Barr ME. 1996. Two more species of *Amphisphaeria* (Xylariales). Mycotaxon 58: 349-351.
- Candoussau F, Katumoto K, Sherwood-Pike M. 1986 ('1985'). Bambusicolous fungi from the Southwest of France I. Two new species of *Pyrenomyces* and a new genus of the *Phacidiaceae*. Sydowia 38: 28-34.
- Hawksworth DL. 1981. *Astrosphaeriella* Sydow, a misunderstood genus of melanommataceous pyrenomyces. Botanical Journal of the Linnean Society 82: 35-59.
- Hawksworth DL. 1985a. A redisposition of the species referred to the ascomycete genus *Microthelia*. Bulletin of the British Museum (Natural History), Botany 14: 43-47.
- Hawksworth DL. 1985b. *Kirschsteiniothelia*, a new genus for the *Microthelia incrustans*-group (*Dothideales*). Botanical Journal of the Linnean Society 91: 181-202.
- Hyde KD. 1996. Fungi from palms. XXIX. *Arecophila* gen. nov. (*Amphisphaeriaceae*, Ascomycota), with five new species and two new combinations. Nova Hedwigia 63: 81-100.
- Hyde KD, Aptroot A, Fröhlich J, Taylor JE. 2000. Fungi from palms. XLIII. *Lophiostoma* and *Astrosphaeriella* species with slit-like ostiole. Nova Hedwigia 70: 143-160.

- Hyde KD, Kang JC, Kong RYC. 1996. Fungi from palms. XXX. Notes on *Amphisphaeria* species described from palms and a description of *A. umbrina*. *Nova Hedwigia* 63: 101-108.
- Krug JC. 1977. The genus *Cainia* and a new family, *Cainiaceae*. *Sydowia* 30: 122-133.
- Müller E, von Arx JA. 1962. Die Gattungen der didymosporen Pyrenomyceten. *Beiträge zur Kryptogamenflora der Schweiz* 11(2): 1-992.
- Sivanesan A. 1975a. New ascomycetes and some revisions. *Transactions of the British Mycological Society* 65: 19-27.
- Sivanesan A. 1975b. Redisposition and description of some *Amphisphaeria* species and a note on *Macrovalsaria*. *Transactions of the British Mycological Society* 65: 395-402.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Academia Sinica, Peking, China, Science Press. 1-1527. (in Chinese)
- Teng SQ. 1936. Additional Fungi from China II. *Sinensia* 7: 490-527.
- Wang YZ, Aptroot A, Hyde KD. 2004. Revision of the ascomycete genus *Amphisphaeria*. Hong Kong, Fungal Diversity Press. 1-168.

***Mycoblastus marginatus*, a new synonym for *M. affinis* (*Mycoblastaceae*, lichenized *Ascomycota*)**

TOBY SPRIBILLE

tspribi@uni-goettingen.de

Albrecht von Haller Institute of Plant Sciences, University of Göttingen
Untere Karspüle 2, D-37073 Göttingen, Germany

TOR TØNSBERG

tor.tonsberg@bm.uib.no

Museum of Natural History, University of Bergen
Allégt. 41, P.O. Box 7800, N-5020 Bergen, Norway

Abstract—*Mycoblastus marginatus* was described in 1937 from a single specimen collected in southern Alaska and has not been reported since. The type material agrees morphologically and chemically with the widespread *Mycoblastus affinis*. We consider *M. marginatus* to be a synonym of the latter.

Key words—acetone insoluble pigment, crustose lichens, Pacific Northwest, planai acid

The genus *Mycoblastus* is widespread at higher latitudes of both the Northern and Southern Hemispheres, and consists of between seven and ten mostly well characterized species. Regional European taxonomic treatments of the genus form the basis for species concepts worldwide. The genus has been discussed for central Europe by Schauer (1964) and for Great Britain by James (1971). The relationship of several poorly known taxa from other regions (e.g., *Lecidea sanguinaria* var. *melinodes* Vain. from Siberia, *M. japonicus* Müll.Arg. from Japan, *M. dissimulans* (Nyl.) Zahlbr. from Chile) to the rest of the genus is not clear. The genus is in need of a systematic revision.

In our work on northwest North American crustose lichens, we encountered the name *Mycoblastus marginatus*, an epiphytic species described from Kodiak Island (Degelius 1937). *Mycoblastus marginatus* was said to differ from all other members of the genus in the apothecia possessing a white ‘border’ and branched paraphyses, and it was mentioned by Schauer (1964) as a parallel

taxon to *Mycoblastus affinis* with white-margined apothecia. It was recognized by Thomson (1997) and continues to be included on the list of North American lichens (Esslinger 2006).

The type specimen of *Mycoblastus marginatus* (studied by us) strongly resembles *M. affinis*. The 'white border' mentioned by Degelius (1937) and Thomson (1997) appears to be little more than a ring of residual thalline tissue that may have persisted during apothecial ontogeny. Such a persistent ring is uncommon but not unknown; it is for instance the basis for the recognition of *Mycoblastus sanguinarius* var. *lecanoroideus* (Nyl.) Zahlbr. from Japan (Schauer 1964). Branching and anastomosing paraphyses are, in fact, given as a characteristic of the Mycoblastaceae by Hafellner (1984) and are present in the type of *Lecidea affinis* in G cited in the protologue (Schaerer 1850). We also compared acetone-insoluble pigments in the apothecia of both types and both contained a bluish pigment that is HNO_3 + mauve, K+ greyish olivaceous following pretreatment with HNO_3 . The pigment appears to be similar to Cinereorufa-green as defined by Meyer & Printzen (2000), although before treatment it appears strongly bluish, not green in water and appears to be HCl- (without pretreatment).

European accounts of the chemistry of *Mycoblastus affinis* vary. Some authors report the thallus to be K- or K+ yellow ($\pm$ atranorin and planaiic acid; Wirth 1996), K+ yellow and UV+ white with unidentified substances (Watson & James 1992) or to contain atranorin, chloratranorin, and planaiic acid (Tønsberg 1992, Foucard 2001). Schauer (1964) did not investigate the chemistry. We conducted thin layer chromatography (TLC) on a small fragment of the type of *M. affinis*. The thallus contained planaiic acid (major) and atranorin (minor constituent) as well as a trace fatty acid; a single apothecium that was analyzed contained planaiic acid only. It is not rare for atranorin to occur in only trace amounts in some specimens of *M. affinis*, which could explain the K- reactions reported by some authors.

When conducting TLC on the type of *M. marginatus* we found that it also contained planaiic acid (major) and atranorin (minor). Given the overall agreement in morphological and chemical characteristics between *Mycoblastus marginatus* and *M. affinis*, we see no justification for maintaining *M. marginatus* as a distinct taxon. We here lectotypify *Mycoblastus affinis* and place *Mycoblastus marginatus* in its synonymy.

Mycoblastus affinis (Schaer.) T. Schauer, in Poelt & Steiner, Lichenes Alpinum 230 (1964).

Basionym: *Lecidea affinis* Schaer., Enumeratio critica lichenum Europaeorum, p. 132 (1850). Lectotype (designated here): [SWITZERLAND]: ad Abietum truncos ad radicem montis Nunenen, [collector unknown], Lichenes Helvetici Exsiccati 629 (G-00053948!); isoelectotype in M (not seen, mentioned by Schauer 1964).

Synonyms:

- Lecidea melina* Kremp. ex Nyl., Annales des Sciences Naturelles, Botanique, 4^e Série 19: 357 (1863). Type: [GERMANY:] ad truncos Pini in Bavaria superiore (M, not seen). Synonymy discussed by Schauer (1964); see also James (1971).
- Mycoblastus marginatus* Degel., Meddelanden från Göteborgs Botaniska Trädgård 12: 115 (1937). Holotype: U.S.A., Alaska, Kodiak Island, Kodiak, 27 Apr 1932, E. Hultén 5054 (UPS-18654!).

Acknowledgments

We thank the curators of the herbaria G and UPS for loans of type specimens and Alan Fryday and Christian Printzen for helpful comments on the manuscript.

Literature

- Degelius G. 1937. Lichens from southern Alaska and the Aleuthian [sic] Islands, collected by Dr. E. Hultén. Meddelanden från Göteborgs Botaniska Trädgård 12: 105-144.
- Esslinger TL. 2006. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (Most Recent Update 10 April 2006).
- Foucard T. 2001. Svenska skorplavar och svampar som växer på dem. Stockholm: Interpublishing. 392 pp.
- Hafellner J. 1984. Studien in Richtung einer natürlicheren Gliederung der Sammelfamilien *Lecanoraceae* und *Lecideaceae*. Beiheft Nova Hedwigia 79: 241-371.
- James PW. 1971. New or interesting British lichens I. Lichenologist 5: 114-148.
- Meyer B, Printzen C. 2000. Proposal for a standardized nomenclature and characterization of insoluble lichen pigments. Lichenologist 32: 571-583.
- Schaerer E. 1850. Enumeratio critica lichenum Europaeorum. Bernae: Staempfli. 327 pp.
- Schauer T. 1964. Die Flechtengattung *Mycoblastus* in Mitteleuropa. Nova Hedwigia 8(3-4): 301-310.
- Thomson JW. 1997. American Arctic lichens. 2. The microlichens. Madison: University of Wisconsin Press. 675 pp.
- Tønsberg T. 1992. The sorediate and isidiate, corticolous, crustose lichens in Norway. Sommerfeltia 14: 1-331.
- Watson MF, James PW. 1992. *Mycoblastus*. pp. 389-392 in: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds.) Lichen flora of Great Britain and Ireland. London: Natural History Museum.
- Wirth V. 1995. Flechtenflora. 2. Auflage. Stuttgart: Ulmer. 660 pp.

Fruitbodies of *Cenococcum geophilum*

L.M. FERNÁNDEZ-TOIRÁN^{1,2} & B. ÁGUEDA¹

lmtoiran@pvs.uva.es

¹ DIEF Valonsadero. Consejería de Medio Ambiente. Junta de Castilla y León
Apartado de correos 175, E-42080 Soria, Spain

² Escuela Universitaria de Ingenierías Agrarias. Universidad de Valladolid
Campus “Los Pajaritos”, E-42005 Soria, Spain

Abstract — Cleistothecia found in a soil sample containing abundant ectomycorrhizae and sclerotia of *Cenococcum geophilum* are described for the first time for the species. Although no connections between the ectomycorrhizae and fruitbodies were found in the sample, the cleistothecia were identified as fruitbodies of *C. geophilum* by comparing their morphology with the morphological characters of *C. geophilum* sclerotia and ectomycorrhizae.

Key Words — sexual structures, anatomical description, taxonomy

Introduction

Cenococcum geophilum Fr. is a cosmopolitan ectomycorrhizal fungus, well known for its wide habitat range (Trappe 1964) and possibly the dominant ectomycorrhizal fungus in arctic, temperate and subtropical forests (Trappe 1962, 1964; Molina & Trappe 1982). It is particularly noted for its drought resistance (Pigott 1982, Coleman et al. 1989). However, this fungus is not limited to dry places, as it has been observed in wet poorly drained soils (Trappe 1962). *C. geophilum* has a pioneering capability, although it is present also in mature stands (De Román & De Miguel 2005, Torres & Honrubia 1997). The ability of the sclerotia to survive for several years can provide sufficient inoculum to effectively colonize host species (Shaw & Sidle 1982).

The ectomycorrhiza of this fungus have been reported to occur on over 200 tree species from 40 different angiosperm and gymnosperm genera (Trappe 1962, 1964; Molina & Trappe 1982). Also, it is one of the most common ectomycorrhizal types in *Quercus ilex* L. stands in the Mediterranean area (Águeda & Fernández-Toirán 2004, De Román & De Miguel 2005, Richard et al. 2005).

Cenococcum geophilum was originally described from its black sclerotia by Sowerby in 1800 under the name *Lycoperdon graniforme* Sowerby (Cairney & Chambers 1999). Fries (1825) introduced the genus *Cenococcum* Moug. & Fr. with the species *C. geophilum* mentioned as a nom. nud. Fries (1829) gave a description of *C. geophilum*, citing *L. graniforme* in synonymy; as a sanctioned name, *C. geophilum* has priority over the earlier *L. graniforme*. The isolation of a “jet-black mycelium” that formed ectomycorrhizae was first identified by Hatch (1934) and the connection of these black ectomycorrhizae to *C. geophilum* was made by Linhell (1942). The identification of *C. geophilum* primarily relies on culture and ectomycorrhizal morphology because there are no known sexual fruitbodies. Until now, the presence of a sexual state has never been reported.

Material and methods

The harvested structures were found in a 600 ha orchard of 29-year-old oak trees (*Quercus ilex* subsp. *ballota* (Desf.) Samp.) during research on the ectomycorrhizae of a *Tuber melanosporum* Vittad. plot. Samples were collected in Oct 2000 from calcareous soil at a single site in the province of Soria, in the municipality of Villaciervos (Castilla y León, Spain), at an elevation of 1250 m. Soil samples were collected from beneath the holmoak and stored at 4 °C for later analysis in the laboratory. Roots with ectomycorrhizae and soil rhizomorphs were carefully extracted with the aid of a stereomicroscope. The excised roots and ectomycorrhizae were cleaned in an ultrasonic bath with desionized water and some drops of Tween 20[®] detergent at 20 °C for 15 min. Samples of the ectomycorrhizae and sexual structures of *C. geophilum* fixed in FAA (Agerer 1986) and lactoglycerin were stored as voucher specimens in DIF Valonsadero. The fruitbodies were found in a sample containing a high number of *C. geophilum* ectomycorrhizae and sclerotia.

The general methodology and terminology for characterizing the structure follows Agerer (1987-2002, 1991) and Agerer & Rambold (2004-2006). The sexual structures were fixed on slides with lacto-glycerin for microscope observation.

Description

Cleistothecia are spherical to oval (Fig. 1a). The outer layers of the cleistothecium are composed of dark pigmented hyphae, which make clusters of isodiametric cells (5 x 4 µm of diameter) surrounded by radiating bundles of elongate cells (15-25(40) x 5-8 µm) forming a stellate pattern (Fig. 1b).

The outer layer is covered with many emanating hyphae with slightly rounded bases, so that some parts of cleistothecium appear to have a layer of smooth

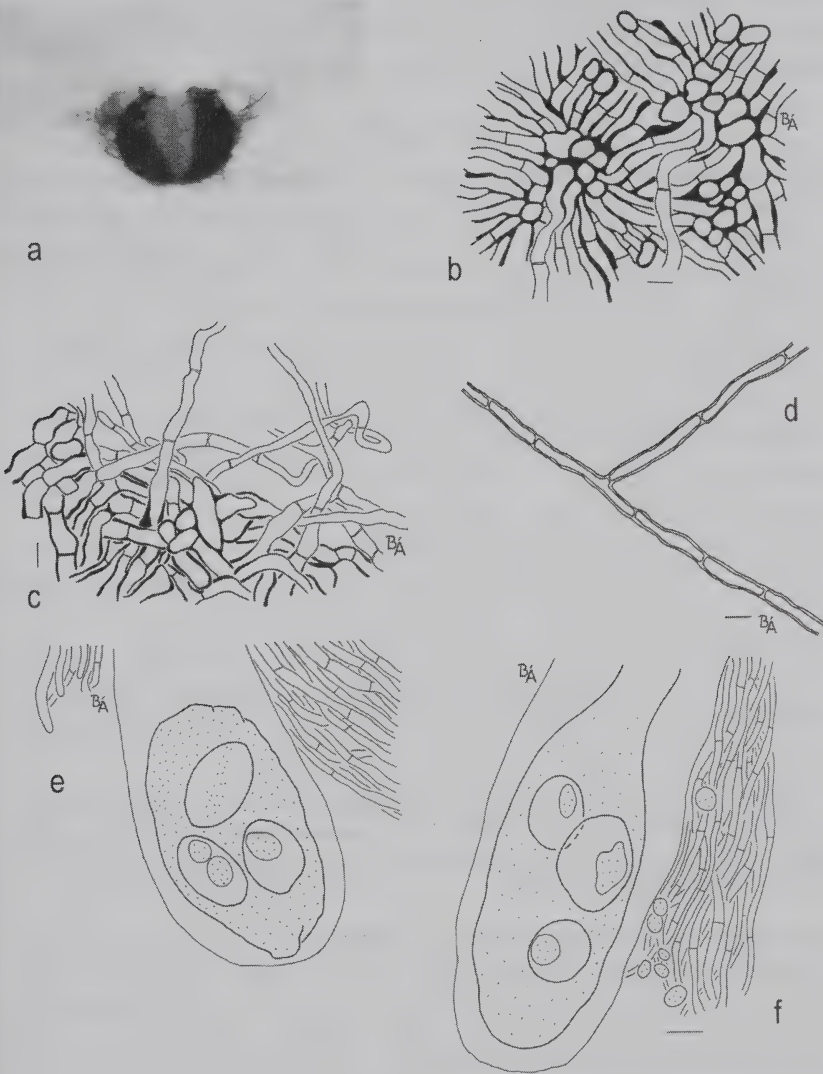


Figure 1: Anatomical characters of the cleistothecium. a. General view morphological aspects of the cleistothecium (63X). b. Outer layer of the cleistothecium with emanating hyphae. c. Margin of the cleistothecium with emanating hyphae. d. Ramified hyphae. e, f. Ascus with ascospores.

All bars 10 μ m.

round cells covered by a dense net of hyphae. These hyphae are quite stiff (although they may also be sinuate), lack clamp connections, and have simple septa (Figs. 1c, d).

Inside the cleistothecia, two hyaline oval to pyriform $81.5\text{--}96 \times 37.5\text{--}44 \mu\text{m}$ asci and hyaline $7.5\text{--}18 \times 3\text{--}5 \mu\text{m}$ hyphae were observed. Each ascus contained three oval, hyaline, $18\text{--}29 \times 15\text{--}19 \mu\text{m}$ ascospores (Figs. 1e, f).

Discussion

The morphological characterization of *Cenococcum geophilum* is very important because although it is one of the most common ectomycorrhizal fungi in different forest types, its fruitbodies have never been described. These fruitbodies were found in a sample containing many *C. geophilum* mycorrhizae and sclerotia. A comparison of these structures with the surface structures of the ectomycorrhizal mantle and the sclerotia shows that all anatomical characters are very similar.

Based on the descriptions of Chilvers (1968) and Trappe (1962), *C. geophilum* ectomycorrhizae are black with black hyphae or have seta radiating from the ectomycorrhiza surface. The mantle is composed of large, darkly pigmented hyphae ($5\text{--}10 \mu\text{m}$) near the surface, and smaller, paler hyphae ($2.5\text{--}4 \mu\text{m}$) adjacent to the host's epidermis. Surface hyphae of the mantle form a typical stellate pattern (Trappe 1971, Hawksworth 1986). All those characters are very similar to the ones found in the described cleistothecia.

The fruitbodies have the same shiny and dark colours as sclerotia. These are spherical with a shiny-smooth surface and brownish-black appearance. Surface hyphae form, as well, a stellate pattern, with thick black hyphae often radiating from the surface (Trappe 1969, Massicotte et al. 1992).

Also, the emanating hyphae have the same appearance of *C. geophilum* mycelia: dark brownish-black and are mostly $3.5\text{--}6.5 \mu\text{m}$ in diameter, generally stiff in appearance, but can be strongly sinuate, with simple septa and $0.2\text{--}0.3 \mu\text{m}$ thick cell walls (Miller & Miller 1983).

All the structures (ectomycorrhizae, sclerotia, cleistothecia) are very similar: dark and shiny colours, brownish-black hyphae without clamps connections, mostly $4\text{--}5 \mu\text{m}$ in diameter, and the outer layers of sclerotia, cleistothecia and mycorrhizae's mantle present the same star-like pattern. This constant in the morphological characters between all the structures would confirm the identification of these fruitbodies. Agerer & Rambold (2004–2006), in the case of *C. geophilum* sclerotia, advise that in the absence of an obvious connection between mycorrhizae and sclerotia, the presence of the same star-like pattern on both ectomycorrhizae and sclerotial outer layers would be sufficient evidence to establish its identity.

C. geophilum is the usual ectomycorrhizae in "truffières" (Iotti et al. 2005, De Román & De Miguel 2005), but it also exhibits a broad range of adaptation

to different ecological conditions. For those reasons, it could be a serious competitor of *T. melanosporum*.

In Spanish truffle orchards, *C. geophilum* appears only in orchards placed in previously forested sites, never orchards established in previously cultivated agricultural land (De Miguel et al. 2006). The fact that *C. geophilum* is found mixed with a high percentage of *T. melanosporum* ectomycorrhizae (Águeda et al. 2005) even in previously forested areas suggests that *Tuber melanosporum* is not easily replaced by *C. geophilum*.

Acknowledgements

The authors thank Dr. F.D. Calonge and Dr. G. Moreno for their manuscript presubmission review and the improvement of the manuscript. We also would like to thank to CATESA-AROTZ for the help on the development of the research during the years. This study was supported by LIFE99ENVE000356. Research by B. Águeda was financed by Junta de Castilla y León, España.

References

- Agerer R. 1986. Studies on ectomycorrhizae II. Introducing remarks on characterisation and identification. *Mycotaxon* 26: 473-492.
- Agerer R. (ed.) 1987-2002. Colour atlas of ectomycorrhizae. 1st-12th del. Schwäbisch Gmünd, Germany: Einhorn-Verlag + Druck GmbH.
- Agerer R. 1991. Characterization of ectomycorrhiza. In: Norris JR, Read DJ, Varma AK, eds. Techniques for the study of mycorrhiza. London, UK: Academic Press, Methods in Microbiology 23: 25-73.
- Agerer R, Rambold G. 2004-2006. 2004 – 2005 [first posted on 2004-06-01; most recent update: 2005-10-25]. DEEMY – An Information System for Determination and Characterisation of Ectomycorrhizae. München, Germany. Retrieved 2004-06-05 from <http://www.deemy.de>.
- Águeda B, Fernández Toirán M. 2004. Ectomycorrhizae present in truffled evergreen oak forests in the North-East of Soria (Spain). Premier Symposium sur les Champignons Hypogés du Bassin Méditerranéen. Rabat (Morocco).
- Águeda B, Fernández-Toirán LM, De Miguel AM. 2005. Characterization and quantification of the ectomycorrhizae of the truffle plantation “Los Quejigares” (Soria, Spain). Abstract IV International Workshop. Edible Mycorrhizal Mushrooms. Murcia (Spain).
- De Miguel AM, Águeda B, Fernández-Toirán LM, González Armada B. 2006. Dynamic of the ectomycorrhizal community in black truffle plantations in Spain. Abstracts 5th International Conference on Mycorrhiza. ICOM 2006.
- De Román M, de Miguel AM. 2005. Post-fire, seasonal and annual dynamics of the ectomycorrhizal community in a *Quercus ilex* L. forest over a 3-year period. *Mycorrhiza* 15: 471-482.
- Cairney JWG, Chambers SM. (eds.). 1999. Ectomycorrhizal fungi. Key Genera in Profile. Springer-Verlag Berlin Heidelberg.
- Coleman MD, Bledsoe CS, Lopushinsky W. 1989. Pure culture response of ectomycorrhizal fungi to imposed water stress. *Can J Bot* 67: 29-39.
- Chilvers GA. 1968. Some distinctive types of eucalypt mycorrhiza. *Aust J Bot* 16: 49-70.
- Fries E. 1825. *Systema Orbis Vegetabilis* I. Lundae. Typographia academica.

- Fries E. 1829. *Systema Mycologicum*, III(Sectio Prior). Gryphiswaldae.
- Hatch AB. 1934. A jet-black mycelium forming ectotrophic mycorrhizae. *Sven Bot Tidskr* 28: 369-383.
- Hawksworth DL. 1986. The evolution and adaptation of sexual reproductive structures in the Ascomycota. In: Rayner ADM, Brasier CM, Moore D (eds.). *Symposium of the British Mycological Society*. Cambridge University Press.
- Iotti M, Maechetti M, Bonuso E, Zambonelli A. 2005. Morphological and molecular characterization of the mycorrhizas of *Inocybe rufuloides* and *I. splendens*. *Mycotaxon* 94: 75-84.
- Linhell D. 1942. *Cenococcum graniforme* als Mykorrhizabildner von Waldbaumen. *Symb Bot Ups* 5:1-18.
- Molina R, Trappe JM. 1982. Patterns of ectomycorrhizal host specificity and potential among Pacific Northwest conifers and fungi. *For Sci* 28: 423-458.
- Massicotte HB, Trappe JM, Peterson RL, Melville LH. 1992. Studies on *Cenococcum geophilum*. II. Sclerotium morphology, germination and formation in pure culture and growth pouches. *Can J Bot* 70: 125-132.
- Miller OK, Miller SL. 1983. Description and identification of selected mycorrhizal fungi in pure culture. *Mycotaxon* 18: 457-481.
- Pigot CD. 1982. Fine structure of mycorrhiza formed by *Cenococcum geophilum* Fr. on *Tilia cordata* Mill. *New Phytol* 92: 501-512.
- Richard F, Millot S, Gardes M, Selosse MA. 2005. Diversity and specificity of ectomycorrhizal fungi retrieved from an old-growth Mediterranean forest dominated by *Quercus ilex*. *New Phytologist* 166: 1011-1023.
- Shaw CG, Sidle RC. 1982. Evaluation of planting sites common to a southeast Alaska clear-cut. II. Available inoculum of the ectomycorrhizal fungus *Cenococcum geophilum*. *Can J For Res* 13: 9-11.
- Torres P, Honrubia M. 1997. Changes and effects of a natural fire on ectomycorrhizal inoculum potential of soil in a *Pinus halepensis* forest. *For Ecol and Manag* 96:189-196.
- Trappe JM. 1962. *Cenococcum graniforme*, its distribution, ecology, mycorrhiza and inherent variation. PhD Diss, University of Washington.
- Trappe JM. 1964. Mycorrhizal host and distribution of *Cenococcum graniforme*. *Lloydia* 27: 100-106.
- Trappe JM. 1969. Studies on *Cenococcum graniforme*. I. An efficient method for isolation from sclerotia. *Can J Bot* 47:1389-1390.
- Trappe JM. 1971. Mycorrhiza-forming Ascomycetes. In: Hacskeylo E. (ed). *Mycorrhizae: Proceedings of the First North American Conference on Mycorrhizae*. USDA Forest Service, Misc Publ 1189.

Coprophilous ascomycetes in Thailand

ONUMA JEAMJITT¹, LEKA MANOCH^{1*},
NIPHON VISARATHANONTH¹, CHIRADEJ CHAMSWARN²,
ROY WATLING³, GEORGE P. SHARPLES⁴ & ANAKE KIJJOA⁵

* *agrlkm@ku.ac.th*

¹Department of Plant Pathology, Faculty of Agriculture, Kasetsart University
Bangkok 10900, Thailand

²Department of Plant Pathology, Faculty of Agriculture, Kasetsart University
Kamphaengsaen Campus, Nakhon Pathom 73140, Thailand

³Caledonian Mycological Enterprises
26 Blinkbonny Av., Edinburgh EH4 3HU, UK

⁴Biomolecular Sciences, Liverpool John Moores University
Byrom Street, Liverpool L3 3AE, UK

⁵Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto,
4099-003 Porto, Portugal

Abstract—Dung samples of wild and domestic animals, including barking deer, buffalo, dromedary camel, cow, sambar deer, eld's deer, elephant, gaur, goat, horse, rabbit, rat and toad, were collected from fourteen locations in Thailand. Identification of the fungal isolates was based on morphological characteristics of colony growth on agar media, fruiting bodies and spore ornamentation using light and scanning electron microscopes. Sixty-eight isolates comprising 12 genera and 15 species of *Ascomycota* were found including *Ascobolus*, *Ascodesmis*, *Cercophora*, *Chaetomium*, *Emericella*, *Gelasinospora*, *Podosordaria*, *Podospora*, *Saccobolus*, *Sordaria*, *Sporormiella*, and *Zopfiella*.

Key words—dung fungi, taxonomy, ecology, pyrenomycetes, discomycetes

Introduction

Ascomycetes are the largest group of fungi, and have a worldwide distribution on various substrates (Kirk et al. 2001). Many are commonly found on dung of herbivorous animals (Bell 1983, 2005). Some are important sources of antibiotics, organic acids, enzymes, and other secondary metabolites of economic importance to pharmaceutical and agricultural enterprises, e.g. *Ascodesmis sphaerospora*, *Sporormiella vexans*, and some non-sporulating fungi (Hein et al. 1998, Soman et al. 1999, Ondeyka et al. 1998).

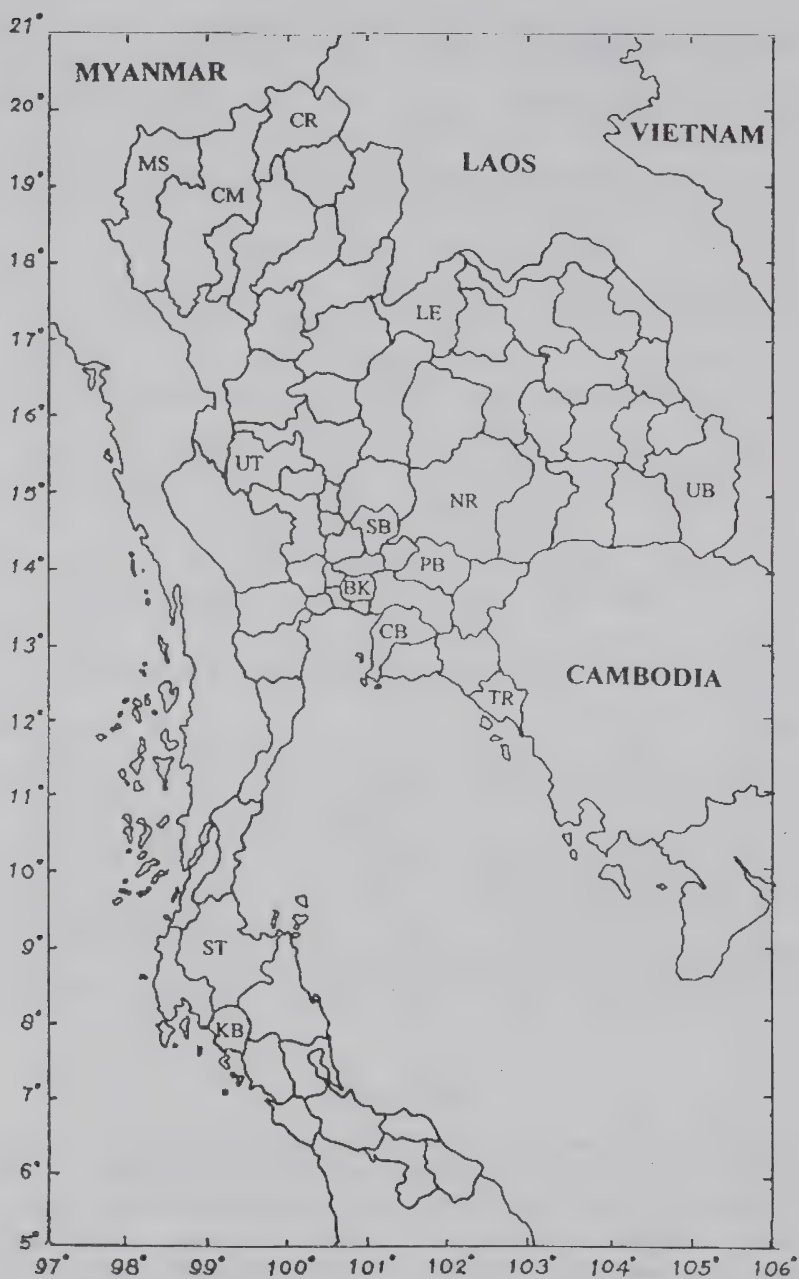


Fig. 1 Map of Thailand showing the collecting sites

However, these fungi have been little studied in Thailand. Van Brummelen (1967, 1969, 1977) reported several coprophilous ascomycetes from Thailand, including *Ascobolus siamensis*, *A. demangei*, *Saccobolus minimus*, *S. thaxteri*, *S. truncatus*, *S. succineus* and *Leptokalpion albicans* from various kinds of dung. Rogers et al. (1998) described *Podosordaria elephantii* as a new species on elephant dung from Chachoengsao Province. Also, Manoch et al. (1999) reported 19 coprophilous ascomycetes from 12 dung samples from Huay Kha Khang Wild Life Sanctuary, Uthai Thani Province and Khao Yai National Park, Nakhon Ratchasima Province. Somrithipol (2004) summarized the approximately 26 genera including 36 species coprophilous ascomycetes known in Thailand.

The present study was aimed to obtaining information on the mycobiota of coprophilous ascomycetes associated with different dung types and to compare their distribution among different sites and dung types in Thailand. In addition, pure cultures of most taxa are being maintained at Kasetsart University for further investigation.

Materials and methods

Sixty dung samples of 13 wild and domestic animals were collected from 14 provinces from June 2002 to July 2004 (Fig. 1, Table 1). Each excrement sample was placed in a moist chamber and positioned near a window. They were incubated for 2-7 days at 28 °C. Direct isolation was from the dung surface under a stereomicroscope. The ascomata were transferred directly onto water agar (WA), squashed to release the ascospores, and incubated for 48 hours. If the ascospores did not germinate, a fine needle was used to transfer the fruiting body with the remaining ascospores from WA and placed in a test tube containing 10 ml, 60-80 °C hot water, 65% ethyl alcohol, and 3% KOH for 30, 15 and 3-5 minutes respectively. The treated ascospores were spread on WA in a Petri dish and incubated for 12-24 hours. A hyphal tip from a single spore was transferred to a slant of potato dextrose agar (PDA) for all species. All isolates are being maintained as pure cultures at Kasetsart University Fungal Collection (KUFC). Dry specimens of dung samples are kept in a herbarium at Kasetsart University (KUH). The soil plate, dilution plate, heat, alcohol treatments and Gochenaure's glucose ammonium nitrate agar (Gochenaure 1964) (NH_4NO_3 1 g, K_2HPO_4 1 g, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 0.5 g, rose bengal 0.03 g, yeast extract 1 g, glucose 5 g, agar 15 g, streptomycin solution 4 ml, distilled water 1 l) as well as 2% malt extract agar were used to isolate the dung fungi. Identification was based on morphological characteristics such as colony growth patterns, color, texture on different agar media and spore ornamentation. Examination was by light and scanning electron microscopes.

Table 1 Frequency of coprophilous ascomycetes on different dung types collected from various locations using different isolation methods.

Fungal species	Total isolates	KUFC	Dung sample	KUH	Method ^a	Location ^{bc}
<i>Ascobolus albidus</i> *	2	2452	elephant (<i>Elephas maximus</i>)	0017	mc	LE
		2453	elephant	0045	mc	CR
<i>Ascodesmis macrospora</i>	3	2454	rat (<i>Rattus rattus</i>)	0016	alc	BK
		2455	rat	0028	dp	BK
		2456	rat	0041	dp	BK
<i>A. sphaerospora</i> *	1	2457	toad (<i>Bufo</i> sp.)	0019	dp	BK
<i>Cercophora silvatica</i>	3	2458	elephant	0010	mc	CM
		2459	elephant	0033	mc	KB
		2460	elephant	0033	mc	KB
<i>Chaetomium crispatum</i>	3	2461	elephant	0004	mc	NR
		2462	cow (<i>Bos taurus</i>)	0021	mc	SB
		2463	cow	0052	sp	TR
<i>C. cupreum</i>	6	2464	cow	0050	mc	UB
		2465	sambar deer (<i>Cervus unicolor</i>)	0003	sp	NR
		2466	elephant	0004	alc	NR
		2467	rabbit	0030	mc	PB
		2468	cow	0044	mc	CR
		2469	eld's deer (<i>Cervus eldi</i>)	0048	mc	CB
<i>C. globosum</i>	19	2470	sambar deer	0003	mc	NR
		2471	sambar deer	0003	alc	NR
		2472	sambar deer	0003	ht	NR
		2473	barking deer (<i>Muntiacus feael</i>)	0002	mc	NR
		2474	rabbit (<i>Oryctolagus cuniculus</i>)	0011	mc	CM
		2475	rabbit	0011	alc	CM
		2476	rabbit	0013	mc	BK
		2477	rabbit	0013	sp	BK
		2478	gaur (<i>Bos gaurus</i>)	0026	alc	UT
		2479	rabbit	0030	mc	PB
		2480	goat (<i>Capra aegagrus</i>)	0034	sp	KB
		2481	goat	0034	alc	KB
		2482	horse (<i>Equus caballus</i>)	0035	mc	KB
		2483	cow	0031	mc	ST
		2484	cow	0031	alc	ST
		2485	cow	0031	ht	ST
		2486	cow	0044	mc	CR
		2487	dromedary camel (<i>Camelus dromedarius</i>)	0047	sp	CB
		2488	eld's deer	0047	sp	CB

Table 1 (Cont.)

Fungal species	Total isolates	KUFC	Dung sample	KUH	Method ^a	Location ^{b,c}
<i>Emericella rugulosa</i>	2	2489	rat	0041	dp	BK
		2490	cow	0044	sp	CR
<i>Gelasinospora brevispora</i> *	1	2491	cow	0052	ht	TR
<i>Podosordaria leporina</i> *	nc		rabbit	0030	mc	PB
<i>Podospora curvicolla</i>	1	2493	sambar deer	0003	sp	NR
<i>Saccobolus glaber</i>	nc		elephant	0017	mc	LE
<i>Sordaria fimicola</i>	16	2495	sambar deer	0003	mc	NR
		2496	sambar deer	0003	sp	NR
		2497	cow	0021	mc	SB
		2498	sambar deer	0003	alc	NR
		2499	sambar deer	0003	ht	NR
		2500	barking deer	0002	mc	NR
		2501	barking deer	0002	sp	NR
		2502	buffalo (<i>Bubalus bubalus</i>)	0012	sp	CM
		2503	gaur	0026	alc	UT
		2504	rabbit	0030	mc	PB
		2505	goat	0034	mc	KB
		2506	goat	0034	alc	KB
		2507	cow	0038	sp	MS
		2508	dromedary camel	0047	sp	CB
		2509	eld's deer	0048	sp	CB
		2510	eld's deer	0048	alc	CB
<i>Sporormiella minima</i> *	10	2511	sambar deer	0003	mc	NR
		2512	cow	0003	ht	NR
		2513	buffalo	0012	alc	CM
		2514	rabbit	0011	mc	CM
		2515	goat	0034	sp	KB
		2516	goat	0034	ht	KB
		2517	rat	0036	dp	BK
		2518	cow	0052	sp	TR
		2519	rat	0054	alc	BK
		2520	toad	0059	dp	BK
<i>Zopfiella latipes</i>	1	2451	sambar deer	0003	alc	NR

^a alc, alcohol treatment; dp, dilution plate method; ht, heat treatment; mc, moist chamber method; sp, soil plate method

^b BK, Bangkok; CB, Chonburi; CM, Chiang Mai; CR, Chiang Rai; KB, Krabi; LE, Loei; MS, Mae Hong Son; NR, Nakhon Ratchasima; PB, Prachinburi; SB, Saraburi; ST, Surat Thani; TR, Trat; UB, Ubol Ratchathani; UT, Uthai Thani

^c See map for distribution

KUFC, Kasetsart University Fungal Collection; KUH, Kasetsart University Herbarium; nc, not cultivated; *, new records for Thailand

Table 2 Occurrence (%) of coprophilous ascomycetes species on different dung types (the number of samples indicated in the brackets).

Fungal species	Dung type												
	barking deer (3)	sambar deer (2)	eld's deer (2)	elephant (8)	gaur (1)	rabbit (4)	dromedary camel (1)	buffalo (4)	cow (12)	goat (2)	horse (1)	rat (13)	toad (7)
<i>Ascobolus albidus</i>	-	-	-	2	-	-	-	-	-	-	-	-	-
<i>Ascodesmis macrospora</i>	-	-	-	-	-	-	-	-	-	-	-	3	-
<i>A. sphaerospora</i>	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Cercophora silvatica</i>	-	-	-	3	-	-	-	-	-	-	-	-	-
<i>Chaetomium crispatum</i>	-	-	-	1	-	-	-	-	2	-	-	-	-
<i>C. cupreum</i>	-	1	1	1	-	1	-	-	2	-	-	-	-
<i>C. globosum</i>	1	3	2	-	1	4	1	1	3	2	1	-	-
<i>Emericella rugulosa</i>	-	-	-	-	-	-	-	-	1	-	-	1	-
<i>Gelasinospora brevispora</i>	-	-	-	-	-	-	-	-	1	-	-	-	-
<i>Podosordaria leporina</i>	-	-	-	-	-	nc	-	-	-	-	-	-	-
<i>Podospora curvicolla</i>	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Saccobolus glaber</i>	-	-	-	nc	-	-	-	-	-	-	-	-	-
<i>Sordaria fimicola</i>	2	4	2	-	1	1	1	1	2	2	-	-	-
<i>Sporormiella minima</i>	-	1	-	-	-	1	-	1	2	2	-	2	1
<i>Zopfiella latipes</i>	-	1	-	-	-	-	-	-	-	-	-	-	-
Total isolate	3	11	5	7	2	7	2	3	13	6	1	6	2
% Occurrence	13	40	20	33	13	33	13	13	47	20	7	20	13

nc, not cultivated

Results and discussion

Sixty-eight isolates of coprophilous ascomycetes were found from 60 dung samples of 13 animals from 14 locations using various isolation methods (Table 1). Twelve genera and 15 species of coprophilous ascomycetes were recorded, including ten pyrenomycetes (66.7%), four discomycetes (26.7 %) and one plectomycete (6.7%). All taxa were cultivated on PDA and CMA, except *Podosordaria leporina* and *Saccobolus glaber* which failed to grow on agar media.

Chaetomium globosum was the most common species with 19 isolates found from all dung samples except elephant, buffalo, rat and toad, followed by *Sordaria fimicola* (16 isolates) and *Sporormiella minima* (10 isolates). It is interesting to note that *Ascobolus albidus*, *Ascodesmis macrospora*, *A. sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Podospira curvicolla*, *Saccobolus glaber* and *Zopfiella latipes* were found on only one type of dung (Table 2).

The moist chamber method yielded the highest number of coprophilous ascomycetes (9 spp.), followed by the soil plate method (7 spp.), alcohol treatment (6 spp.), heat treatment (4 spp.), and dilution plate method (4 spp.). The results indicated that for wild animals, sambar deer dung yielded the highest number of fungal species (6 spp.), followed by elephant (5 spp.) and rabbit (5 spp.). For domestic animals, most fungal species were found on cow dung (7 spp.), followed by goat (3 spp.) and rat (3 spp.).

Ascobolus albidus P. Crouan & H. Crouan, Anns Sci. Nat., Bot., Sér. 4, 10: 193, 1858.

(Figs. 2, A-D)

References: Bell (1983), Richardson & Watling (1997).

Specimens examined: Thailand. Loei: Phu Kradung National Park, on elephant dung, 31 Dec. 2002, KUH 0017 (KUFC 2452). Chiang Rai: Muang District, on elephant, 16 Jan. 2004, KUH 0045 (KUFC 2453).

Colonies on PDA growing slowly, reaching 1.5-2.0 cm diam in 7 days at 28 °C. Mycelium whitish brown, submerged, forming apothecia in 12-14 days. Apothecia submerged, colourless to pale yellowish, then dotted with the dark-colored spores. Asci 8-spored, clavate, 180-220 x 30-35 µm. Ascospores ellipsoidal, 20-30(-33) x 10-15 µm, golden brown, ornamentation consisting of anastomosing rows of striations parallel to the long axis of the spore.

Richardson & Watling (1997) described 21 species of *Ascobolus*, while 12 species were observed on dung in New Zealand (Bell 1983). *Ascobolus albidus* was found on cervid and lagomorph dung (Bell 1983). Bell (2005) reported that *Ascobolus albidus* was the only species found on five types of dung including rabbit, brumby, eastern gray kangaroo, wombat and swamp wallaby in Australia. Richardson (2001) reported *Ascobolus albidus* on sheep, deer, cattle, rabbit, hare and grouse collected worldwide from 1994 to 2000.

Van Brummelen (1967) reported *Ascobolus demangei* and *A. siamensis* from goat dung, in Uthai Thani Province. Somrithpol & Hywel-Jones (2002) recorded eight isolates of *Ascobolus* spp. from wildlife including sambar deer, barking deer, Asian elephant and cattle dung from Northeastern Thailand. In this study, two isolates of *Ascobolus albidus* were found on elephant dung from Loei and Chiang Rai Provinces collected in the cold season. This fungus is a new record for Thailand.

Ascodesmis macrospora W. Obrist, Can. J. Bot. 39: 951, 1961. (Figs. 3, A-C; 4)
References: Obrist (1961), Richardson & Watling (1997).

Specimens examined: Thailand. Bangkok: Bang Sue, on rat dung, 9 June 2002, KUH 0016 (KUFC 2454); 15 May 2003, KUH 0028 (KUFC 2455); 19 Oct. 2003, KUH 0041 (KUFC 2456).

Colonies on PDA growing rapidly, reaching 8-9 cm diam in 7 days at 28 °C. Mycelium whitish brown, with white tufts of aerial hyphae, forming apothecia in 12-14 days. Apothecia minute, hemisphaerical to subglobose, soft-fleshed, 100-200 µm, first hyaline, becoming dark brown at maturity. Asci 8-spored, broadly clavate, oblong, elliptical or ovoid, 80-90 × 20-33 µm, opening by a slightly obliquely attached operculum, thin-walled. Ascospores one-celled, broadly ellipsoid, 17-22 × 12-17 µm, first hyaline, then pale brown, becoming dark brown at maturity, ornamented with reticulum, spores discharged at once through opening of operculum.

Manoch et al. (1999) reported an *Ascodesmis* sp. from toad dung which resembled *A. macrospora* found in this study. This research confirmed the occurrence of *A. macrospora* in toad dung using the alcohol treatment method (Manoch et al. 1999). In addition, Manoch et al. (1999) reported *Ascodesmis porcina* from soil using the alcohol treatment method. Richardson & Watling (1997) presented a key to the six species of *Ascodesmis* from dung: *A. macrospora*, *A. nana*, *A. sphaerospora*, *A. microscopica*, *A. porcina* and *A. nigricans*.

Ascodesmis sphaerospora W. Obrist, Can. J. Bot. 39: 948, 1961. (Figs. 3, D-F; 5)
References: Obrist (1961), Richardson & Watling (1997).

Specimen examined: Thailand. Bangkok: Bang Sue, on toad dung, 2 Feb. 2003, KUH 0019 (KUFC 2457).

Colonies on PDA growing rapidly, reaching 8-9 cm diam in 7 days at 28 °C. Mycelium brownish white, cottony, forming apothecia in 12-14 days. Apothecia subglobose, soft-fleshed, 80-200 µm, scattered or gregarious, hyaline, superficial, without excipulum, with many asci surrounded by paraphyses. Asci 8-spored, broadly clavate, oblong or ovoid, 50-80 × 25-30 µm, opening by a slightly obliquely attached operculum, thin-walled. Ascospores one-celled, spherical to ellipsoid, 10-11 × 10.5-11 µm, L/B ratio mostly < 1.2, first hyaline, then pale brown, becoming dark brown at maturity, ornamented with a dark brown reticulations and ridges.

Ascodesmis sphaerospora was isolated from toad dung in Bangkok using the dilution plate method. This fungus is a new record in Thailand. Hein et al.

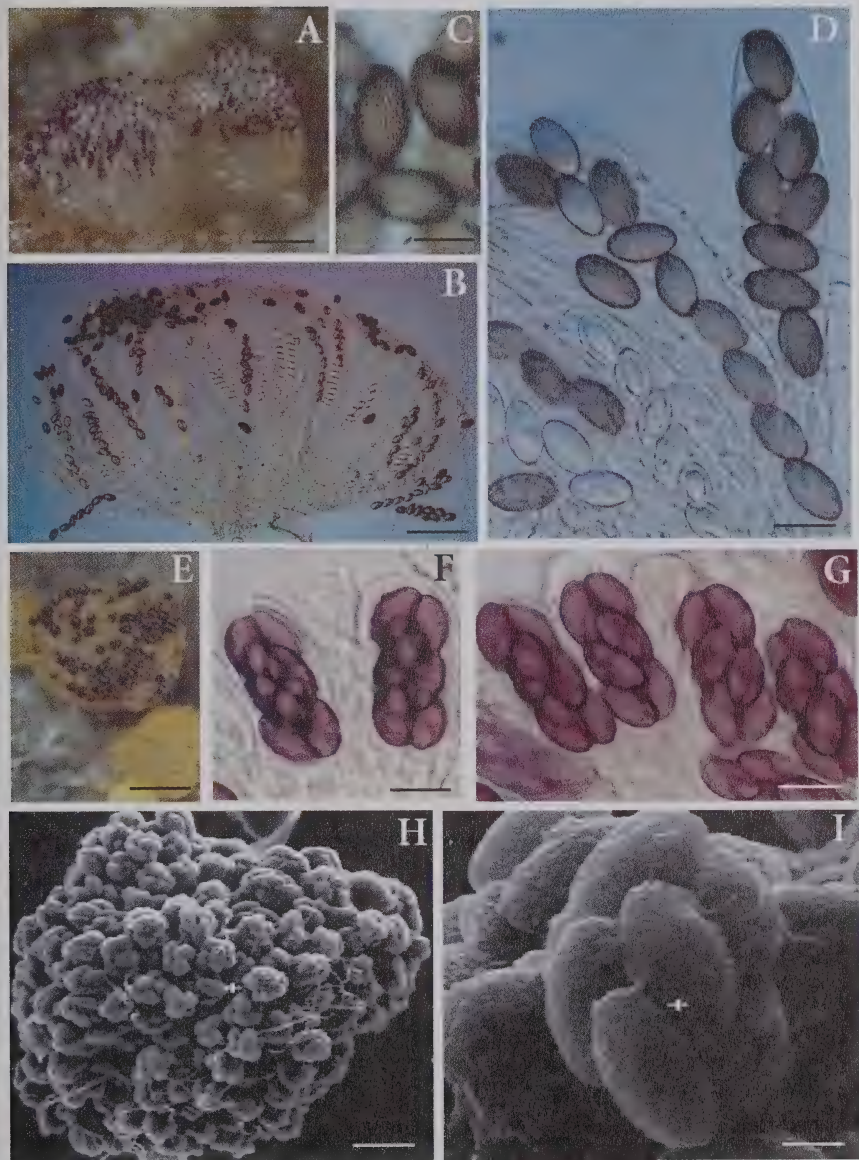


Fig. 2 A-D. *Ascobolus albidus* (KUFC 2452): A. apothecia on elephant dung, B. squash mount of apothecium; C, D. asci and ascospores; young, nearly mature and mature ascospores; E-I. *Saccobolus glaber* (KUFC 2494): E. apothecia with spore-masses inside, as seen on elephant dung; F, G. asci, spore-masses with 8 ascospores in each; H, I. SEM photomicrographs of intact apothecium with spore-masses and high magnification of ascospores.

Bars: A, E = 0.2 mm; B = 100 μ m; C, F, G = 20 μ m; D = 30 μ m; H = 50 μ m, I = 10 μ m.

(1998) reported *A. sphaerospora* from bison dung in Canada which produces arugosin F and a xanthone and can inhibit *Bacillus subtilis*, *Staphylococcus aureus* and the coprophilous fungi *Ascobolus furfuraceus* and *Sordaria fimicola* in vitro. *A. sphaerospora* is a new record for Thailand.

Cercophora silvatica N. Lundq., Symb. bot. upsal. 20(1): 103, 1972.

References: Lundqvist (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Chiang Mai: Mae Sa elephant camp, on elephant dung, 7 Nov. 2002, KUH 0010 (KUFC 2458). Krabi: Lanta Island, on elephant dung, 10 Aug. 2003, KUH 0033 (KUFC 2459, KUFC 2460).

Colonies on PDA growing slowly, reaching 5-6 cm diam in 14 days at 28 °C. Mycelium whitish to pale brown, forming perithecia in 10-14 days. Perithecia obpyriform, 500-530 x 300-400 µm, with protruding neck and tapered tufts of hair, immersed. Asci 8-spored, cylindrical, 200-220 x 16-18 µm, subapical globules absent. Ascospores immature sigmoid, hyaline, 35-50 x 3-3.5 µm; mature spores ellipsoid, dark brown, 15-16 x 7-9 µm; pedicel cylindrical, hyaline, 28-32 x 3-4 µm; the upper and basal cauda eccentrically attached.

Cercophora silvatica was found only on elephant dung from Chiang Mai, Northern Thailand and Krabi, Southern Thailand by the moist chamber method. This fungus was recorded from New Zealand (Bell 1983), but was not found in Australia (Bell 2005). In Thailand, Manoch et al. (1999) reported *Cercophora coprophila* from cow and rabbit dung from Loei and Bangkok, respectively. *C. silvatica* is a new record for Thailand.

Chaetomium crispatum (Fuckel) Fuckel, Jb. nassau. Ver. Naturk. 23-24: 90, 1870.

References: Arx et al. (1986), Domsch et al. (1993), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on elephant dung, 16 June 2002, KUH 0004 (KUFC 2461). Saraburi: Maung District, on cow dung, 14 April 2003, KUH 0021 (KUFC 2462). Trat: Goad Island, on cow dung, 16 March 2004, KUH 0052 (KUFC 2463).

Colonies on PDA, reaching 9 cm diam in 14 days at 28 °C. Mycelium whitish to yellow-green, forming perithecia in 7-10 days. Perithecia globose to subglobose, grey to grey-black, 300 x 200 µm; lateral hairs numerous, dark olive-brown; terminal hairs, wavy or very loosely coiled, olive-brown. Asci 8-spored, cylindrical, hyaline. Ascospores lemon-shaped with broadly apiculate ends, 9-10 x 6.5-7 µm.

This species has been reported on dung of various animals, soil, dead flies and seed of various plants (Domsch et al. 1993).

Chaetomium cupreum L.M. Ames, Mycologia 41: 642, 1949.

References: Ames (1963), Arx et al. (1986).

Specimens examined: Thailand. Ubol Ratchathani: Sirinthorn District, on cow dung, 25 Feb. 2002, KUH 0050 (KUFC 2464). Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2465); on elephant dung, 16 June 2002, KUH 0004 (KUFC 2466). Prachinburi: Tub Larn National Park, on rabbit dung, 26

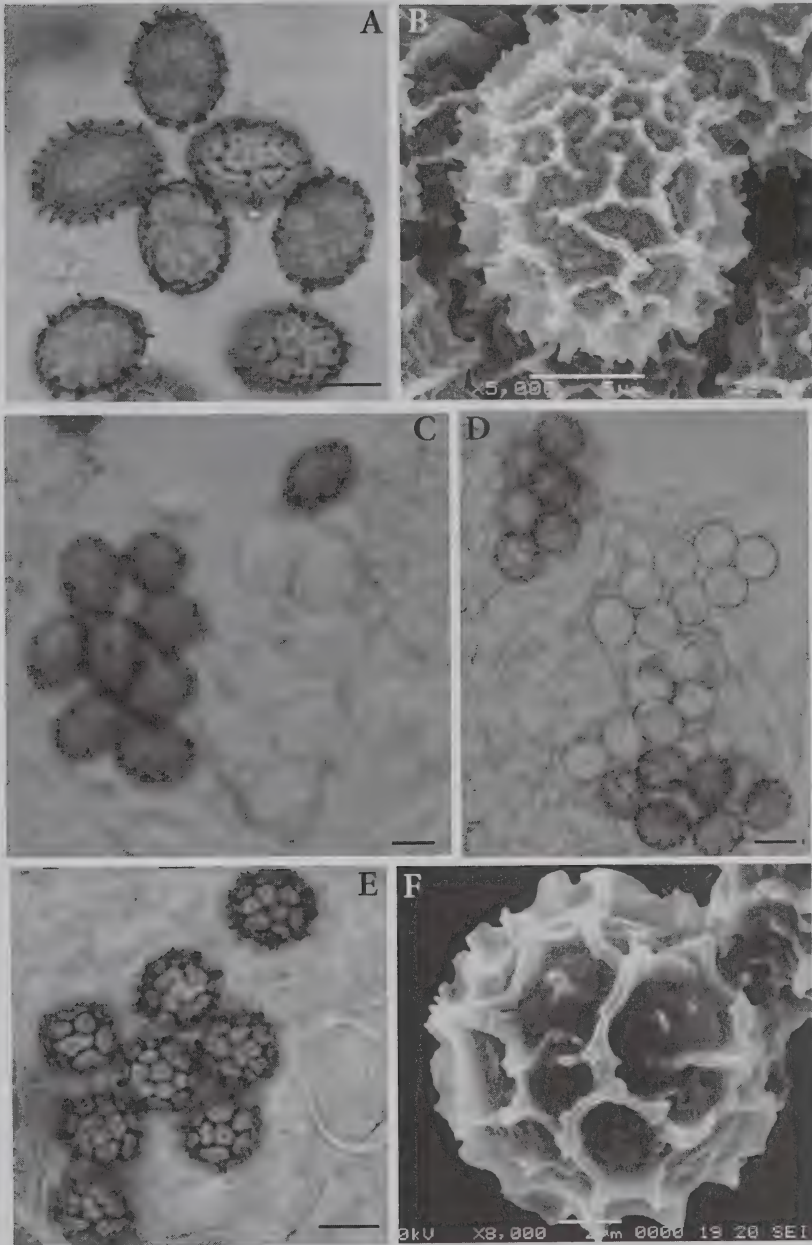


Fig. 3 A-C. *Ascodesmis macrospora* (KUFC 2454): A, B. ascospores; C. young ascus and ascospores; D-E. *A. sphaerospora* (KUFC 2457): D. young asci and ascospores; E, F. ascospores.

Bars: A, C, D, E = 10 µm; B = 5 µm; F = 2 µm.

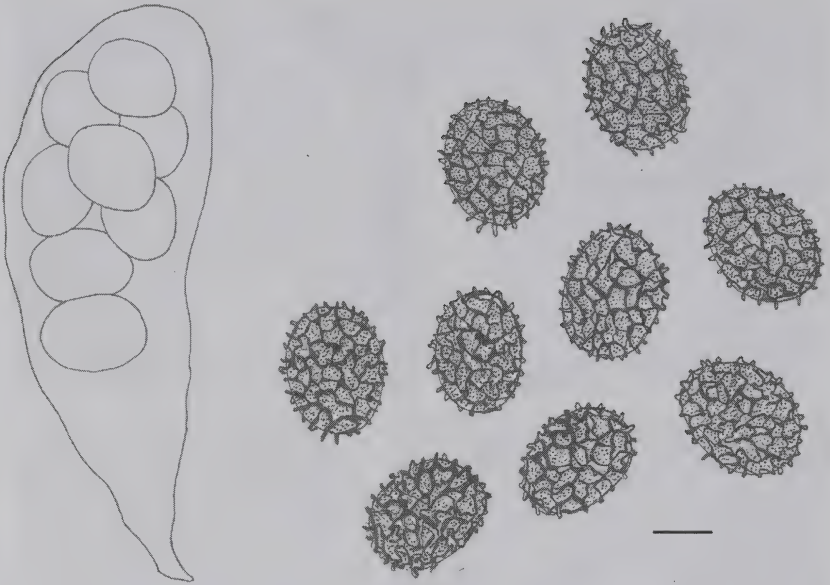


Fig. 4 *Ascodesmis macrospora* (KUFC 2454): camera lucida drawing of ascus and ascospores (bar = 10 μ m).

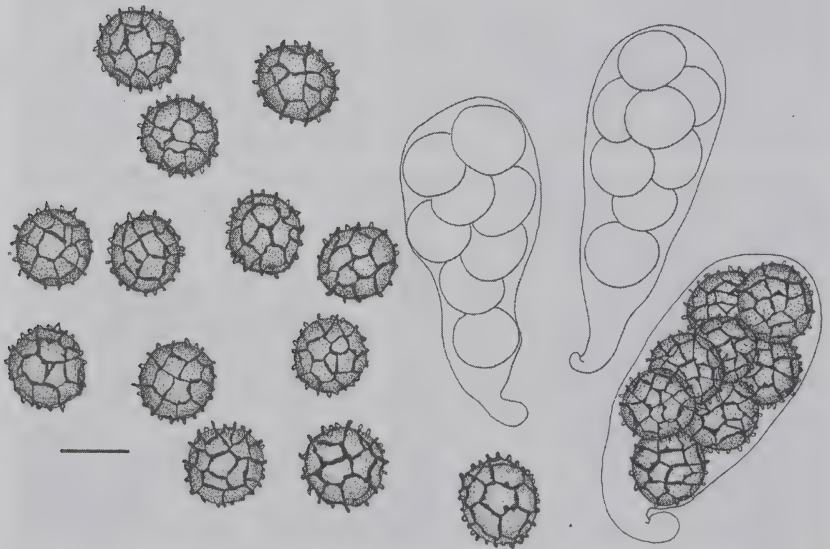


Fig. 5 *Ascodesmis sphaerospora* (KUFC 2457): camera lucida drawing of asci and ascospores (bar = 10 μ m).

June 2003, KUH 0030 (KUFC 2467). Chiang Rai: Maung District, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2468). Chonburi: Khao Kheow Open Zoo, on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2469).

Colonies on PDA growing slowly, reaching 9 cm diam in 14 days at 28 °C. Mycelium whitish to grey, reverse red to brown, forming perithecia in 5-7 days. Perithecia globose to subglobose, golden red-brown, 270-300 × 180-220 µm; terminal hairs wavy or very loosely coiled, dark brown with tips. Asci 8-spored, short clavate, colourless. Ascospores one-celled, lemon-shaped, with two apical germ-pores, 8-10 × 6.5-8 µm.

Chaetomium globosum Kunze, Mykologische Hefte 1: 16, 1817.

References: Arx et al. (1986), Domsch et al. (1993), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2470, KUFC 2471, KUFC 2472); on barking deer, 16 June 2002, KUH 0002 (KUFC 2473). Chiang Mai: Queen Sirikit Botanic Garden, on rabbit dung, 7 Nov. 2002, KUH 0011 (KUFC 2474, KUFC 2475). Bangkok: Kasetsart Univ., on rabbit dung, 14 Nov. 2002, KUH 0013 (KUFC 2476, KUFC 2477). Uthai Thani: Haay Kha Khang Wild Life Sactuary, on gaur dung, 2 May 2003, KUH 0026 (KUFC 2478). Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (KUFC 2479). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2480, KUFC 2481); on horse dung, 10 Aug. 2003, KUH 0035 (KUFC 2482). Surat Thani: Maung District, on cow dung, 8 Aug. 2003, KUH 0031 (KUFC 2483, KUFC 2484, KUFC 2485). Chiang Rai: Horticulture Research Institute, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2486); Chonburi: Khao Kheow Open Zoo, on dromedary camel dung, 17 Feb. 2004, KUH 0047 (KUFC 2487); on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2488).

Colonies on PDA growing rapidly, reaching 9 cm diam in 7 days at 28 °C. Mycelium dense, olivaceous, grey layer of ascomata, forming a grey layer of perithecia in 5-7 days. Perithecia globose to subglobose, dark brown, 200-300 × 200-250 µm; terminal hairs wavy or very loosely coiled, dark olive-brown. Asci 8-spored, short clavate, colourless. Ascospores one-celled, lemon-shaped, greenish brown, 8-12 × 6.5-8 µm, with two apical germ pores.

Chaetomium species occur worldwide in temperate and tropical regions and are mainly found on soil and fresh droppings of horse, squirrel, goat, rabbit and antelope (Domsch et al. 1993) and dung of various animals in New Zealand and Australia (Bell 1983, 2005). *Chaetomium cupreum* and *C. globosum* are both reported to produce secondary metabolites which are mycotoxins (Kanokmedhakul et al. 2002).

Emericella rugulosa (Thom & Raper) C.R. Benj., Mycologia 47: 680, 1955. (Fig. 6, F) Reference: Raper & Fennell (1965).

Specimens examined: Thailand. Bangkok: Bang Sue District, on rat dung, 19 Oct. 2003, KUH 0041 (KUFC 2489). Chiang Rai: Horticulture Research Insitute, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2490).

Colonies on PDA growing slowly, reaching 2-2.5 cm diam in 10-14 days at 28 °C. Mycelium with sparse green conidial heads. Abundant purple-brown cleistothecia

formed in 5-7 days, globose to subglobose, red-brown, $200 \times 370 \mu\text{m}$, surrounded by globose, colourless, hülle cells. Asci 8-spored, globose to subglobose, colourless. Ascospores lenticular, rugulose, with two sinuate equatorial crests, purple-red, $4.0\text{--}4.5 \mu\text{m}$ diam $\times$ $3.0\text{--}3.5 \mu\text{m}$ thick.

Anamorph: *Aspergillus rugulosus* Thom & Raper, Mycologia 31: 660, 1939.

Conidiophores smooth-walled, pale brownish, $40\text{--}80 \mu\text{m}$ long. Conidial head columnar. Conidia globose, rugulose, $3.5\text{--}4 \mu\text{m}$.

E. rugulosa is a common soil fungus and was reported from several places in the USA; the type strain was isolated from New Jersey soil (Raper & Fennell 1965). Other habitats include forest nurseries, alkaline soils, mangrove mud and the rhizosphere of various cultivated plants (Domsch et al. 1993).

Gelasinospora brevispora R.S. Khan & J.C. Krug,

Mycologia 81: 226, 1989.

(Fig. 6, G)

Reference: Khan & Krug (1989).

Specimens examined: Thailand. Trat: Goad Island, on cow dung, 16 March 2004, KUH 0052 (KUFC 2491).

Colonies on PDA growing slowly, reaching 9 cm diam in 14 days at 28°C . Mycelium brown to dark brown, forming perithecia in 7-10 days. Perithecia scattered, immersed, globose to subglobose, brown to dark brown, ostiolate, $300\text{--}500 \times 200\text{--}400 \mu\text{m}$. Asci 8-spored, cylindrical, colourless, $140\text{--}200 \times 18\text{--}30 \mu\text{m}$. Ascospores one-celled, subglobose to ellipsoidal, hyaline when young, becoming olivaceous brown to dark brown, with walls uniformly ornamented with numerous, uniformly round or ovate depressions (or pits), provided with a circular germ pore at each end, $26.5\text{--}28 \times 18\text{--}20 \mu\text{m}$.

Khan & Krug (1989) described *Gelasinospora brevispora* as a new species on cow, herbivore and zebra dung (Holotype) from Kenya, and cow and elephant dung from Tanzania. In this study, we found only one isolate of *G. brevispora* from cow dung collected from Goad Island, Trat Province, Eastern Thailand. This fungus is a new record for Thailand.

Podosordaria leporina (Ellis & Everh.) Dennis,

Kew Bull. 1957: 306, 1957.

(Fig. 7, A-E)

References: Richardson & Watling (1997), Ellis & Ellis (1998).

Specimens examined: Thailand. Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (non cultivated).

Ascstroma conspicuous on dung, $0.2\text{--}0.8 \text{ mm}$. Perithecia in a subglobose group at the tip of a stromatic stalk, $180\text{--}200 \times 90\text{--}100 \mu\text{m}$. Asci 8-spored, cylindrical, colourless, $150\text{--}180 \times 14\text{--}16 \mu\text{m}$. Ascospores one-celled, ellipsoidal, dark brown, with germ-slit, slightly flattened on one side, $15\text{--}17.5 \times 8\text{--}10 \mu\text{m}$.

Podosordaria leporina was reported on rabbit dung from Prachinburi Province, Thailand; its ascospores are characteristically slightly flattened on side. Richardson & Watling (1997) gave the ascospores as (12-) $14\text{--}19 \times 6\text{--}9 \mu\text{m}$.

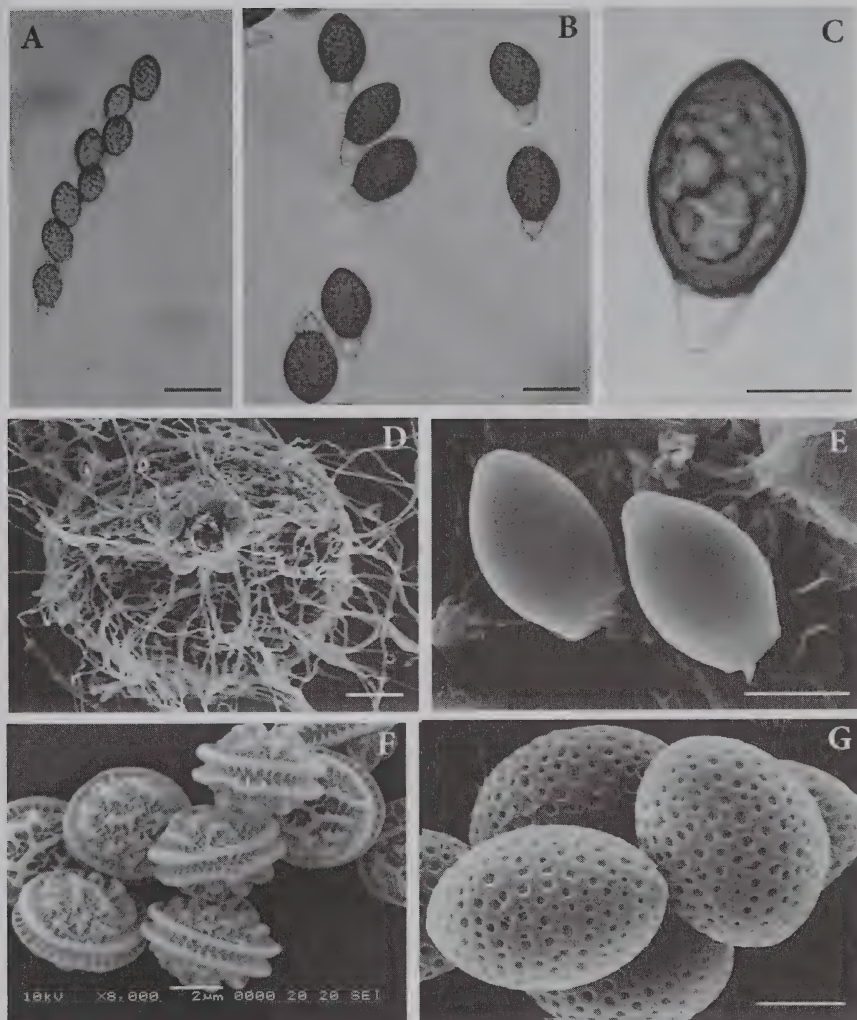


Fig. 6 A-E. *Zopfiella latipes* (KUFC 2451): A. ascus and ascospores; B, C. ascospores; D, E = SEM photomicrographs of ascoma and ascospores; F. *Emericella rugulosa* (KUFC 2489): ascospores; G. *Gelasinopora brevispora* (KUFC 2491): ascospores.

Bars: A = 30 μ m; B, D, E = 20 μ m; C, G = 10 μ m; F = 2 μ m

The stalks of stroma from our isolate were shorter than those described by Richardson & Watling (1997). Rogers et al. (1998) described *Podosordaria elephanti* as a new species from elephant dung collected in Chachoengsao Province, Thailand. Bell (2005) reported *Podosordaria violacea* from wallaby

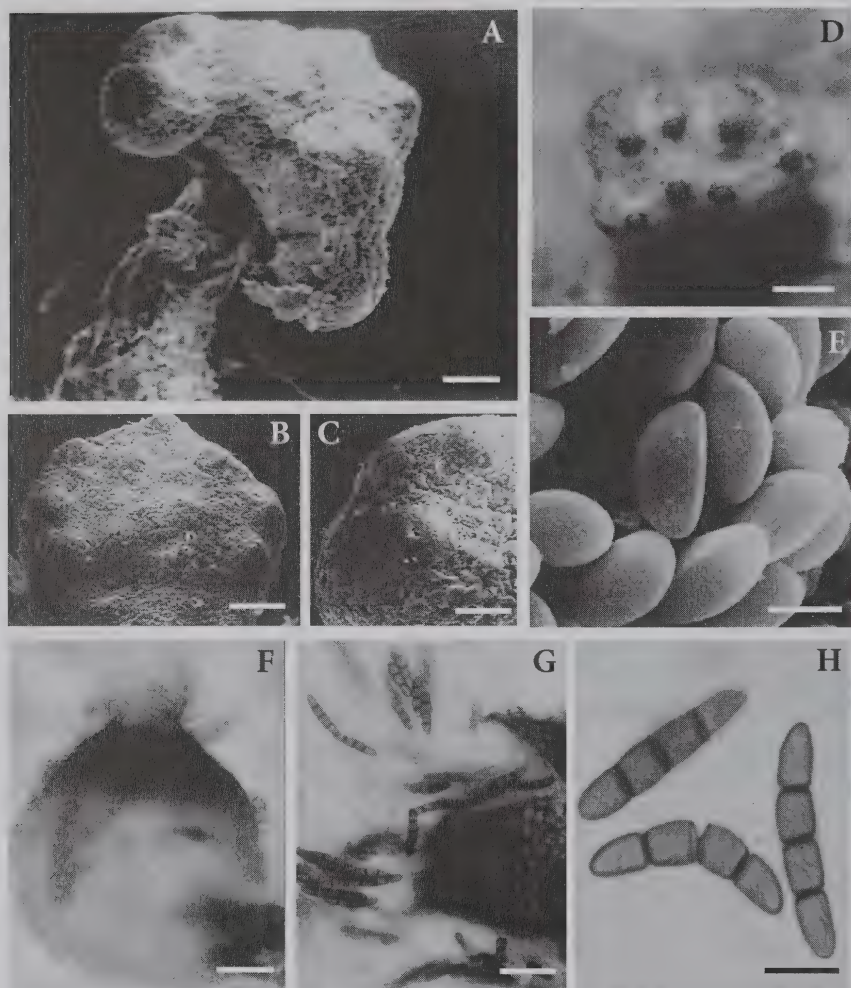


Fig. 7 A-E. *Podosordaria leporina* (KUFC 2492): A-C. SEM photomicrographs of ascostroma with perithecia; D. ascostroma on rabbit dung under stereomicroscope; E. ascospores; F-H. *Sporormiella minima* (KPFC 2514): F. perithecium, G. squash mount of perithecia, asci and ascospores, H. Ascospores with germ slit.

Bars: A, B = 100 μ m; D = 0.2 mm; C = 50 μ m; E, H = 10 μ m; F = 20 μ m; G = 30 μ m

dung and *Podosordaria* sp. from Brush tail possum dung in Australia. *P. leporina* is a new record for Thailand.

Podospora curvicolla (G. Winter) Niessl, Hedwigia 22: 156, 1883.

References: Lundqvist (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2493).

Colonies on CMA growing slowly, reaching 5-5.5 cm diam in 14 days at 28 °C. Mycelium brown to dark brown, submerged, forming perithecia in 10-14 days. Perithecia obpyriform, with tufts of hair, immersed, brown to dark brown, 500-550 x 400-470 µm. Asci 256-spored, broadly clavate, colourless, 200-230 x 60-110 µm. Ascospores one-celled, subglobose to ellipsoidal, hyaline when young, becoming brown to dark brown, 15-16 x 9-10 µm; hyaline pedicel, 10-12 x 2-2.5 µm.

Podospora curvicolla was reported on lagomorph and possum dung in New Zealand (Bell 1983); and on cow, goat, rabbit, sheep and yellow ox dung in Taiwan (Wang 2000). In Thailand, Manoch et al. (1999) recorded *P. curvicolla*, *P. communis* and *P. anserina* from deer dung.

Saccobolus glaber (Pers.) Lambotte, Flora myc. Belg.,

Suppl. 1: 284, 1887.

(Fig. 2, E-I)

References: van Brummelen (1967), Bell (1983), Richardson & Watling (1997), Ellis & Ellis (1998).

Specimens examined: Thailand. Loei: Phu Kradung National Park, on elephant dung, 31 Dec. 2002, KUH 0017 (non cultures).

Apothecia produced on dung after 2 days incubation at 28 °C, soft-fleshed, pale yellowish, 100-120 x 25-30 µm. Asci 8-spored, unitunicate, cylindrical with operculum, at maturity elongating to project above the surface of apothecium, the spores within standing out as dark dots under stereomicroscope. Ascospores one-celled, ellipsoidal with truncated ends, purple, smooth-walled, 20-25 x 10-14 µm, firmly joined together with mucilage both in the ascus and after ejection.

Saccobolus glaber was found on elephant dung using the moist chamber method, but failed to grow on agar media. Somrithipol (2004) recorded the following *Saccobolus* species from Thailand: *S. citrinus*, *S. glaber*, *S. minimus*, *S. succineus*, *S. thaxteri* and *S. truncatus*. van Brummelen (1967) reported *S. minimus*, *S. thaxteri*, *S. truncatus* from animal dung in Thailand and described *S. succineus* as a new species collected from elephant and horse dung from Kanchanaburi Province (van Brummelen 1969). Manoch (2000) reported *S. citrinus* from deer, banteng and cow dung from Huay Kha Khang Wildlife Sanctuary, Uthai Thani Province; Khoa Yai National Park, Nakhon Ratchasima Province and Loei Province, Northern Thailand. Somrithipol & Hywel-Jones (2002) found *S. citrinus*, *S. glaber* and *S. thaxteri* from various dung including sambar deer, barking deer, Asian elephant and cattle from Northeastern Thailand.

Sordaria fimicola (Roberge ex Desm.) Ces. & De Not.,

Comm. Soc. Crittog. Ital. 1: 226, 1863.

References: Lundqvist (1972), Ellis & Ellis (1998).

Specimens examined: Thailand. Saraburi: Maung District, on cow dung, 14 April 2002, KUH 0021 (KUFC 2497). Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2495, KUFC 2496, KUFC 2498, KUFC 2499); on barking deer, 16 June 2002, KUH 0002 (KUFC 2500, KUFC 2501). Chiang Mai: Mae

Tang District, on buffalo dung, 7 Nov. 2002, KUH 0012 (KUFC 2502). Uthai Thani: Haug Kha Khang Wild Life Sactuary, on gaur dung, 2 May 2003, KUH 0026 (KUFC 2503). Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (KUFC 2504). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2505, KUFC 2506). Mae Hong Son: Maung Distric, on cow dung, 9 Oct. 2003, KUH 0038 (KUFC 2507). Chonburi: Khao Kheow Open Zoo, on dromedary camel dung, 17 Feb. 2004, KUH 0047 (KUFC 2508); on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2509, KUFC 2510).

Colonies on PDA growing rapidly, reaching 9 cm diam in 7 days at 28 °C. Mycelium brown to dark brown, forming perithecia in 7-10 days. Perithecia obpyriform, superficial, dark brown, 300-400 x 250-330 µm. Asci 8-spored, unitunicate, cylindrical, shortly stipitate, with truncate apex from thickened apical ring, colourless, 160-200 x 15-17 µm. Ascospores one-celled, ovoid to ellipsoidal, hyaline when young, becoming brown to dark brown, 15-20 x 10-12 µm, with germ pore at the apiculate basal end, covered with a wide gelatinous sheath.

Sordaria fimicola is recorded from horse, rabbit, cow and many other kinds of animals, mostly herbivorous dung from many countries (Bell 1983, 2005; Domsch et al. 1993, Richardson & Watling 1997, Elshafie 2005). Manoch et al. (1999) reported *S. fimicola* from deer and banteng dung in Thailand.

***Sporormiella minima* (Auersw.) S.I. Ahmed & Cain,**

Pakist. J. scient. Ind. Res. 12: 241, 1970.

(Fig. 7, F-H; 8)

References: Ahmed & Cain (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2511); Pak Thong Chai District, on cow dung, 25 Oct. 2002, KUH 0009 (KUFC 2512). Chiang Mai: Mae Tang District, on buffalo dung, 7 Nov. 2002, KUH 0012 (KUFC 2513); Queen Sirikit Botanic Garden, on rabbit dung, 7 Nov. 2002, KUH 0011 (KUFC 2514). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2515, KUFC 2516). Bangkok: Kasetsart Univ., on rat dung, 26 Sept. 2003, KUH 0036 (KUFC 2517). Trat: Goad Island, on cow dung, 16 March 2003, KUH 0052 (KUFC 2518). Bangkok: Kasetsart Univ., on rat dung, 4 April 2004, KUH 0054 (KUFC 2519); on toad dung, 19 July 2004, KUH 0059 (KUFC 2520).

Colonies on PDA growing slowly, reaching 5-5.5 cm diam in 14 days at 28 °C. Mycelium whitish to pale brown, submerged, forming perithecia in 10-14 days. Perithecia subglobose or pyriform, immersed when young and becoming superficial at maturity, dark brown, peridium thin, membranaceous, scattered or loosely aggregated, 100-150 x 85-100 µm. Asci 8-spored, unitunicate, cylindrical, broadly rounded above, shortly stipitate, colourless, 80-110 x 15-18 µm. Ascospores four-celled, cylindrical, broadly rounded at the ends, straight or curved, each spore free and surrounded by its own gelatinous sheath, 32-35 x 5-6.5 µm, tending to break into two at the middle septum.

Sixty-six species of *Sporormiella* were recorded by Ahmed & Cain (1972). They also reported *S. minima* on several dung samples, such as bear, carnivore, cow, deer, fox, goat, horse, moose, rabbit and sheep from Europe, Canada, Mexico and the United States. Bell (2005) reported this fungus from brush



Fig. 8 *Sporormiella minima* (KUFC 2514): camera lucida drawing of bitunicate asci and ascospores showing prominent germ slits (bar = 10 μm).

tail possum, fawn footed melomys, kangaroo, nabarlek, pademelon, quokka, wallaby, wallaroo and wombat dung from Australia. Richardson (2001) found this fungus on sheep, deer, cattle, rabbit, hare and grouse. In the present study, *S. minima* was the dominant coprophilous ascomycete found on several dung samples (Table 1) and it is a new record for Thailand.

Zopfiella latipes (N. Lundq) Malloch & Cain., Can. J. Bot. 49: 876, 1971. (Fig. 6, A-E)

Reference: Lundqvist (1972)

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2451).

Colonies on CMA growing slowly, reaching 5.0-5.5 cm diam in 14 days at 28 °C. Mycelium brown to dark brown, forming cleistothecia in 10-14 days. Cleistothecia dark brown, globose to subglobose, 300-500 x 200-400 µm. Asci 8-spored, cylindrical, 145-150 x 24-26 µm. Ascospores broadly clavate and unequally two-celled, 19-23 x 14-16 µm for the upper cell, dark in color and 6-7 x 5-5.5 µm for the hyaline pedicel.

Cain (1956) described *Tripterospora* as a new genus of coprophilous ascomycetes. Lundqvist (1972) reported this species, as *Tripterospora latipes*, from soil in Copenhagen and from submerged wood in Maryland, USA. However, Malloch & Cain (1971) proposed *Zopfiella latipes* as the correct name for *T. latipes*. This fungus is a new record for Thailand.

Conclusions

Twelve genera and 15 species of coprophilous Ascomycetes were recorded. All taxa were obtained in pure culture except *Podosordaria leporina* and *Saccobolus glaber*. Among them, *Ascobolus albidus*, *Ascodesmis macrospora*, *A. sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Podospora curvicolla* *Saccobolus glaber* and *Zopfiella latipes* were found on only one type of dung. The most common species were *Chaetomium globosum*, *Sordaria fimicola* and *Sporormiella minima*. The diversity of coprophilous fungi depends on the type and number of dung samples, habitats, collecting sites and isolation techniques used.

Nothworthy ascomycetes representing new records for Thailand are *Ascobolus albidus*, *Ascodesmis sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Sporormiella minima*, and *Zopfiella latipes*.

Acknowledgments

We wish to acknowledge the Thailand Research Fund (TRF) for the financial support of this research under the Royal Golden Jubilee Ph.D. Program for OJ. We are most grateful to Prof. Jack D. Rogers and Prof. David L. Hawksworth for their valuable suggestions, comments and reviewing the manuscript. We thank Prof. Nils Lundqvist, Dr. Ann Bell and Dr. Mike Richardson for providing us with the useful references on coprophilous fungi.

Literature Cited

- Ahmed SI, Cain RF. 1972. Revision of the genera *Sporormia* and *Sporormiella*. Canadian Journal of Botany 50: 419-477.
- Ames LM. 1963. A monograph of the *Chaetomiaceae*. U.S. Army Res. Development Ser. 2: 1-125.
- Arx JA von, Guarro J, Figueras MJ. 1986. The ascomycete genus *Chaetomium*. Beih. Nova Hedwigia 84:1-162.
- Bell A. 1983. Dung fungi an illustrated guide to coprophilous fungi in New Zealand. Victoria Univ. Press: Wellington. 88 pp.
- Bell A. 2005. An illustrated guide to the Coprophilous Ascomycetes of Australia. CBS: Utrecht. 172 pp.
- Cain RF. 1956. Studies of coprophilous ascomycetes IV. *Tripterospora*, a new cleistocarpous genus in a new family. Canadian Journal of Botany. 34: 699-710.
- Domsch KH, Gams W, Anderson TH. 1993. Compendium of Soil Fungi. Vol. 1 & 2. 2nd edn. IHW: Verlag. 859 pp., & 405 pp.
- Ellis MB, Ellis JP. 1998. Microfungi on Miscellaneous Substrates: an identification handbook. 2nd edn. Richmond Publishing: Slough. 246 pp.
- Elshafie AE. 2005. Coprophilous mycobiota of Oman. Mycotaxon 93: 355-357.
- Gochenaour S. 1964. A modification of the immersion tube method for isolating soil fungi. Mycologia 56: 921-923.
- Hein SM, Gloer JB, Scott JA, Malloch D. 1998. Arugosin F: a new antifungal metabolite from the coprophilous fungus *Ascodesmis sphaerospora*. Journal of Natural Product 61: 1566-1567.
- Kanokmedhakul S, Kanokmedhakul K, Phonkerd N, Soyong K, Kongsaree P, Suksamrarn A. 2002. Antimycobacterial anthraquinone-chromanone compound and diketopiperazine alkaloid from the fungus *Chaetomium globosum* KMITL-N0802. Planta Medica 68: 832-836.
- Khan RS, Krug JC. 1989. New species of *Gelasinospora*. Mycologia 81(2): 226-233.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the fungi. 9th edn. CAB International. 655 pp.
- Lundqvist N. 1972. Nordic *Sordariaceae* s. lat. Symbolae Botanicae Upsaliense, 20(1):1-374.
- Malloch D, Cain RF. 1971. New cleistothecial *Sordariaceae* and a new family, *Coniochaetaceae*. Canadian Journal of Botany 49: 869-880.
- Manoch L. 2000. Fungi. In: Review of Biodiversity Research in Thailand. Biodiversity Research and Training Programme (BRT), Bangkok Thailand. pp. 219-246.
- Manoch L, Chana C, Athipunyakom P. 1999. Diversity of coprophilous fungi in Thailand. In Proceedings of International Conference on Asean Network on Microbial Research. Chiang Mai. Thailand. Nov. 29-Dec. 1, 1999. pp. 675-688.
- Obrist W. 1961. The genus *Ascodesmis*. Canadian Journal of Botany 39: 943-953.
- Ondeyka JG, Giacobbe RA, Bills GF, Cuadrillero C, Schmatz DM, Goetz A, Zink DL, Singh SB. 1998. Coprophilin: an anticoccidial agent produced by a dung inhabiting fungus. Bioorganic and Medicinal Letter 8: 3439-3442.
- Raper KB, Fennell DI. 1965. The Genus *Aspergillus*. Williams & Wilkins Company: Baltimore, Md. 686 pp.
- Richardson MJ. 2001. Diversity and occurrence of coprophilous fungi. Mycological Research 105: 387-402.
- Richardson MJ, Watling R. 1997. Keys to Fungi on Dung. British Mycological Society, London. 68 pp.

- Rogers JD, Ju YM, San Martín F. 1998. *Podosordaria*: a redefinition based on cultural studies of the type species, *P. mexicana*, and two new species. Mycotaxon 67: 61-72.
- Soman AG, Gloer JB, Koster B, Malloch D. 1999. Sporovexins A-C and a new preussomerin analog: antibacterial and antifungal metabolites from the coprophilous fungus *Sporormiella vexans*. Journal of Natural Products 62: 659-661.
- Somrithipol S, Hywel-Jones NJ. 2002. A preliminary investigation on coprophilous fungi in Northeastern Thailand. In Proceedings of 40th Kasetsart University Annual Conference. Bangkok. Thailand. pp. 409-414.
- Somrithipol S. 2004. Coprophilous fungi. In Thai Fungal Diversity. (Jones EBG, Tanticharoen M, Hyde KD, eds). BIOTEC. Thailand. pp. 119-128.
- van Brummelen J. 1967. A world-monograph of the genus *Ascobolus* and *Saccobolus* (*Ascomycetes*, *Pezizales*). Persoonia 1: 1-260.
- van Brummelen J. 1969. Studies on discomycetes-III. Persoonia 5: 225-231.
- van Brummelen J. 1977. A new genus of *Pezizales* from Thailand. Kew Bulletin 31: 617-620.
- Wang YZ. 2000. The genus *Podospora* in Taiwan. Mycotaxon 76: 373-391.

***Colletotrichum yunnanense* sp. nov.,
a new endophytic species from *Buxus* sp.**

XIAOYING LIU^{1,2} XIANGMING XIE¹ JUNXING DUAN^{2,3}

XYIL@novozymes.com

¹ Department of Microbiology, Beijing Forestry University
Beijing 100083, China

² Novozymes R/D, China,

³ Key Laboratory of Systematic Mycology and Lichenology, Institute of Microbiology,
Chinese Academy of Sciences, PO Box 2714, Beijing 100080, P.R. China

Abstract—During our study of endophytic fungi from woody plants, an interesting *Colletotrichum* species was isolated. The morphological characteristics, such as slow growing, cylindrical and large conidia, and irregularly lobed appressoria, plus phylogenetic analysis based on nuclear rDNA sequences indicate that the fungus represents a distinct new species and named as *Colletotrichum yunnanense*. It is described and illustrated herewith.

Keywords—taxonomy, morphology, ITS1-5.8S-ITS2

Introduction

The genus *Colletotrichum* contains saprophytic, endophytic and plant pathogenic species. Pathogenic species cause economically significant diseases (anthracnose) of a wide range of plants such as fruits, vegetables, cereals, and forage (Bailey & Jeger 1992). Species of the genus are also one of the most frequently isolated endophytes in various herbaceous and woody plants (Lumyong et al. 2000). The species concept of *Colletotrichum* is neither well-established nor universally accepted due to the very few available morphological criteria in taxonomy, such as shape and size of conidia, setae and appressoria. Molecular techniques like Random Amplification of Polymorphic DNA (RAPD), Restriction Fragment Length Polymorphism (RFLP) and sequence analysis of the intergenic transcribed spacers (ITS) region have been used to aid identifications of *Colletotrichum* species. Sequence analyses of the rDNA ITS region have been demonstrated to be valuable in delineating the species (Sreenivasaprasad et al. 1992).

Host specificity of *Colletotrichum* species has been deemed less important and the number of species in the genus was reduced to 25 by Sutton (1980). *Colletotrichum* diversity from herbaceous plants, Proteaceae and Iwokrama Forest Reserve in South Africa provided new evidences for the host preference (Lu et al. 2004, Lubbe et al. 2004, Photita et al. 2005). New species of *Colletotrichum* were described in recent years (Moriwaki et al. 2003, Nakamura et al. 2006). During our study of the endophytic fungi from woody plants in China, an interesting fungus of *Colletotrichum* was isolated. The slow growing, larger conidia, irregularly lobed appressoria, and phylogenetic analyses based on nuclear rDNA sequences indicate that the fungus represents a new species.

Materials and methods

Fungal isolation— Fresh leaves were sampled and placed into an envelope. After taking to laboratory within a week, the leaves were cut into small pieces of 2 mm², sterilized in 0.1% NaClO for 1 minute and placed onto Potato Dextrose Agar (PDA, Difco) plate containing 100 µg ml⁻¹ streptomycin and 50 µg ml⁻¹ tetracycline. Two weeks later, the mycelia growing from pieces of leaves were transferred onto another PDA plate for morphological study.

Morphology— The fungus was cultured on PDA plate in dark at 25°C. Morphological characteristics and the growth rate were measured after incubation for two weeks. The appressoria were induced by incubating the conidia in distilled water for 24 hours. Observation, measurement and photograph were carried out in water or cotton blue lacto-phenol mounts under Nikon80i microscope with differential interference contrast (DIC). All microscopic characteristics were measured from more than 50 individuals in water mounts.

Phylogenetic analysis— Fresh mycelium was collected from the cultures on PDA plates. Genomic DNA was extracted from fresh mycelia using a modified CTAB method (McGarvey & Kaper 1991). The ITS region including the intervening 5.8S rDNA was amplified with the standard primers, ITS1 and ITS4 (White et al. 1990). The ITS sequences obtained and additional ones of the similar species of *Colletotrichum* and *Glomerella* from GenBank were submitted to molecular phylogenetic analysis. *Plectosphaerella cucumerina* L36640 was chosen as outgroup. Sequence alignment was generated by the program package Clustal-X 1.81 (Thompson et al. 1997), then manually realigned using BioEdit version 5.0.6 (Tom Hall, Department of Microbiology, North Carolina State University, Raleigh, NC 27695). Phylogenetic analysis was performed using PAUP* 4.0 beta 10 (Swofford 2001) with gaps as missing data and all characters equally weighted.

Table 1. Sequences used in phylogenetic analyses based on sequences of rDNA ITS region

Species name	GenBank no.	Strain
<i>Colletotrichum acutatum</i>	AJ749677	CA318
<i>Colletotrichum acutatum</i>	AJ749672	CA473
<i>Colletotrichum agaves</i>	DQ286219	CBS318.79
<i>Colletotrichum agaves</i>	DQ286221	AR3920
<i>Colletotrichum coccodes</i>	AJ301953	BBA 62126
<i>Colletotrichum coccodes</i>	AB233340	MAFF 306629
<i>Colletotrichum crassipes</i>	AY376530	STE-U 4445
<i>Colletotrichum crassipes</i>	AY376529	STE-U 5302
<i>Colletotrichum dracaenophilum</i>	DQ286207	MEP1537
<i>Colletotrichum dracaenophilum</i>	DQ286211	MEP1518
<i>Colletotrichum gloeosporioides</i>	AY438549	IMI376909
<i>Colletotrichum gloeosporioides</i>	AY438550	IMI388809
<i>Colletotrichum phormii</i>	DQ286134	AR3389
<i>Colletotrichum phormii</i>	DQ286140	MEP1334
<i>Colletotrichum</i> sp.	AY438553	IMI377083
<i>Colletotrichum</i> sp.	AY442184	IMI377082
<i>Colletotrichum truncatum</i>	AJ301937	BBA 70523
<i>Colletotrichum truncatum</i>	AJ301976	BBA 71346
<i>Colletotrichum yunnanense</i>	EF369490	AS3.9617
<i>Colletotrichum yunnanense</i>	EF369491	AS3.9616
<i>Glomerella graminicola</i>	AF289231	99355
<i>Glomerella graminicola</i>	AF289222	99409
<i>Plectosphaerella cucumerina</i>	L36640	

Taxonomy

Colletotrichum yunnanense Xiao Ying Liu & W.P. Wu, sp. nov.

FIGURE 1

MYCOBANK #: MB 510584.

Coloniae in PDA tarde crescentes, margine irregulares, albae vel cremeae, pannosae cum mycelio aereo, reversae stramineo-flavae vel avellaneae. Sclerotia presentia. Setae intra conidiomata distributae, 1-4-septatae, 50-80 × 3-6 µm, basi brunneae, ad apicem obtuso-rotundatum pallide brunneae, rectae vel undatae. Conidiophora gregaria et fasciculata, e superficie sclerotiorum producentia, tubulosa, 1-3-septata, 10-30 × 3-5 µm, ad basin brunnea, cellula conidiogena hyalina singulari reducta sunt. Cellulae conidiogenae cylindricae, pallidissime brunneae, laevigatae, monoblasticae vel polyblasticae, collarettae vel interdum ad locum conidiogenum annulatae, 6-12 µm longae, 3-5 µm latae. Conidia holoblastica, cylindrica, bacilliformia vel laeviter clavata, laevia, (14-) 16-21 × 5-6 µm, utroque rotundata, ad basim cicatrice abscissa praedita, aseptata, hyalina, guttulata, facile germinantia tum medio septum formantia, tubus germinationis e extremitatibus ambabus conidiorum prodiens. Appressoria irregulariter lobata, brunnea vel fusco-brunnea, 7-12 × 6-8 µm.

Etymology: The specific epithet refers to the locality of the fungus.

Holotype: WU47182, a dried culture of 20 days old on PDA of AS3.9617, isolated from healthy leaves of *Buxus* sp., Kunming Botanical Garden, Yunnan, China, W. P. Wu, Nov. 5, 2004, deposited in Wu's herbarium, Novozymes R/D, China. Living cultures (AS 3.9617, AS 3.9616) were deposited in China General Microbiological Culture Collection Center and preserved in liquid nitrogen.

Isolates examined: AS3.9617 and AS3.9616, isolated from healthy leaves of *Buxus* sp., Kunming Botanical Garden, Yunnan, China, Nov. 5, 2004, W. P. Wu.

Colonies on PDA slow growing, edge irregular, white to cream, felted with aerial mycelium, reverse straw yellow to hazel. Sclerotia present. Setae distributing within conidiomata, 1-4 septate, 50-80 × 3-6 µm, brown at the base, pale brown at the bluntly rounded apex, straight or wavy. Conidiophores congregative and fasciated, produced from the surface of sclerotia, tubbiness, 1-3-septate, 10-30 × 3-5 µm, brown at the base, reduced to single hyaline conidiogenous cell. Conidiogenous cells cylindrical, slightly brown, smooth, monoblastic or polyblastic, collarette or occasionally annellide at the conidiogenous loci, 6-12 µm long, 3-5 µm wide. Conidia holoblastic, cylindrical, bacilliform or slightly clavate, smooth, (14-) 16-21 × 5-6 µm, rounded at both ends with a abscission scar at the base, no septate, hyaline with oil drops. Conidia easily germinated with formation of septum at the middle, each germ tube formed at both ends of conidia, appressorium irregularly lobed, brown to dark, 7-12 × 6-8 µm.

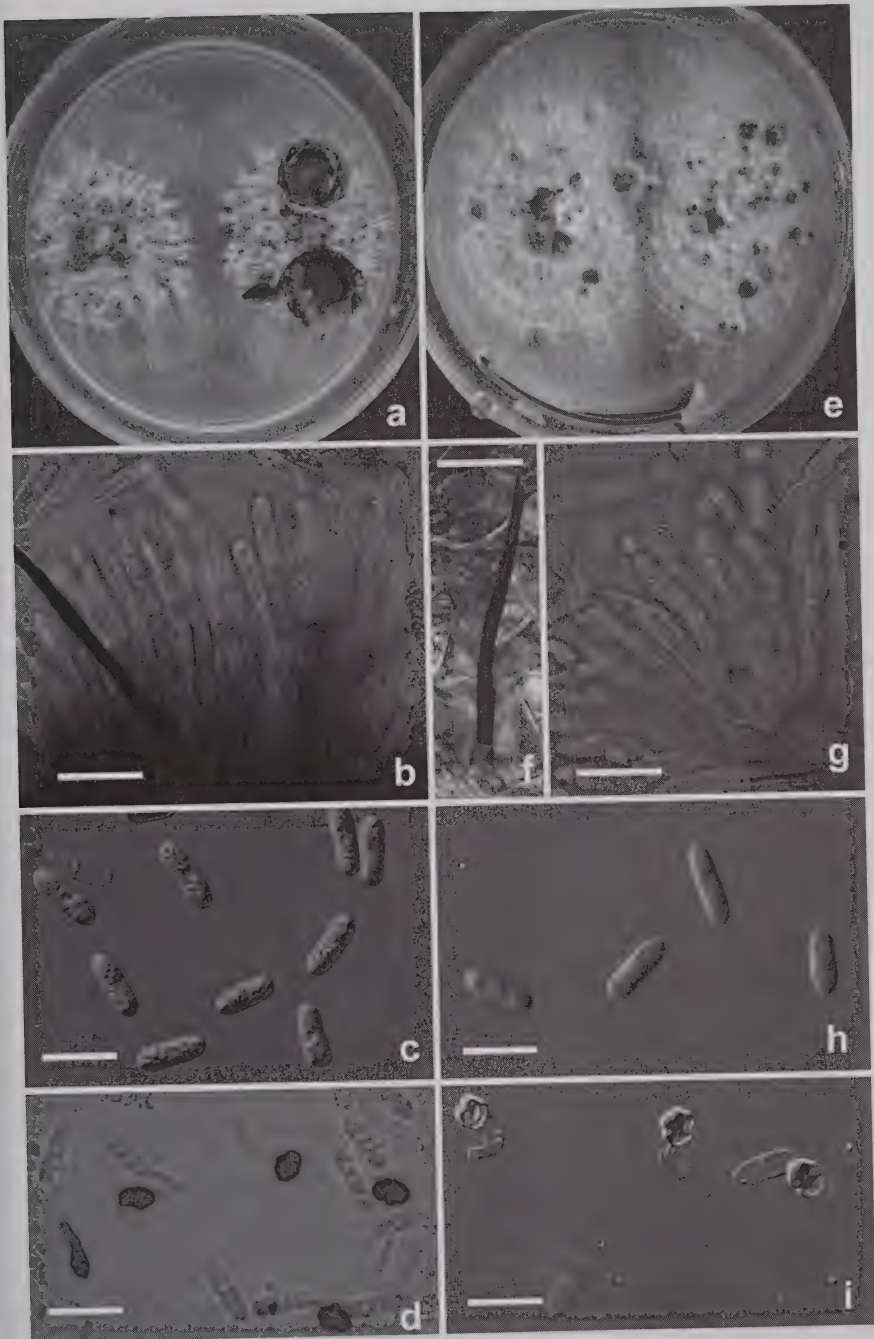
Phylogenetic analysis

Maximum parsimony analysis of the ITS sequences (Fig. 2) yielded a single tree. The phylogram showed that *C. yunnanense* was clustered together with species of *Colletotrichum* and *Glomerella* with high bootstrap support when *Plectosphaerella cucumerina* L36640 as outgroup. *C. yunnanense* represented a clade which paralleled with other species, indicating that *C. yunnanense* is a distinct species. *Colletotrichum dracaenophilum* (DQ286207 and DQ286211) grouped with *C. yunnanense* with 100% bootstrap support. However, the conidia size of *C. yunnanense* is much smaller than that of *C. dracaenophilum* [(20-) 22-34 (-38) × (5.5-) 6.5-9.5 (-10) µm].

Discussion

Both AS3.9617 and AS3.9616 were isolated from the same leaf sample in Kunming Botanical Garden, Yunnan. However, there are somewhat differences in morphology. AS3.9617 is slower growing and produces more compact

Fig. 1. *Colletotrichum yunnanense* sp. nov.: a, e. Colony on PDA; b, g. Conidiogenous cells; b, f. Setae; c, h. Conidia; d, i. Germinated conidia with appressoria. a-d from AS3.9617, e-i from AS3.9616. Scale bar = 20 µm.



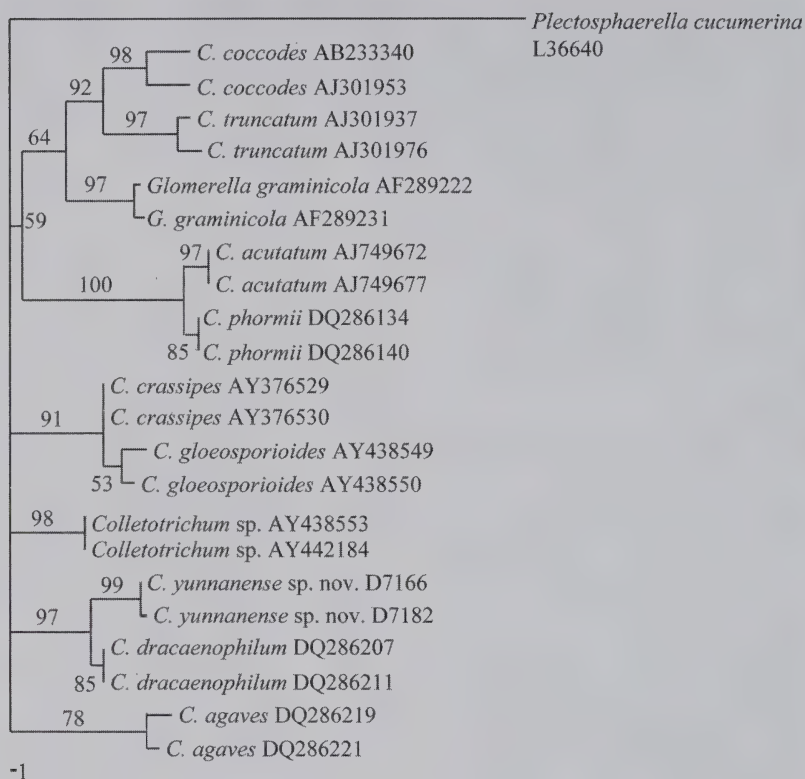


Fig. 2. Phylogram obtained from a maximum parsimony analysis of the ITS1, 5.8S rDNA and ITS2 sequence data of *Glomerella* / *Colletotrichum* species. The tree was rooted to *Plectosphaerella cucumerina* L36640. Branch support is based on 1000 bootstrap replicates and is shown at the nodes. The bar represents 1 substitution per site.

aerial mycelium than AS3.9616. Although *C. dracaenophilum* (DQ286207 and DQ286211) (Farr et al. 2006) was grouped with AS3.9616 and AS3.9617 with high bootstrap support (97%), the larger size conidia and fast growing of *C. dracaenophilum* were significant different from that of *C. yunnanense*. *Colletotrichum yunnanense* resembles *C. crassipes* in slow growing, cylindrical conidia and irregularly lobed appressoria, whereas, the latter differs in the black-brown colony on reverse side, chocolate aerial mycelium and shorter conidia [$10\text{--}15 \times 4.5\text{--}6.5 \mu\text{m}$ vs. (14-) $16\text{--}21 \times 5\text{--}6 \mu\text{m}$] (Sutton 1980). Phylogenetic analysis based on ITS sequences also distinguished the two species.

Because morphological identification of *Colletotrichum* spp. is hampered by phenotypic variation (Nirenberg et al. 2002), it is essential to link the

morphological characteristics to molecular data. Based on independent observations (Brown & Soepena 1994), it suggests the connection and agreement between molecular analysis and morphological characteristics are necessary in separating some species of the genus. *C. yunnanense* is distinguished from other species of *Colletotrichum* either in morphology or the molecular data. Combination of detailed morphological characteristics and sequence analyses of more divergent loci will provide more comprehensive understanding of *Colletotrichum* taxonomy and are likely useful in distinguishing the very closely related taxa.

Acknowledgements

Authors thank Dr J.Y. Zhuang from Institute of Microbiology, the Chinese Academy of Science, Beijing for preparing the Latin diagnosis, and Dr. W.Y. Zhuang of the same institute and Dr W.P. Wu from R/D Novozymes, Demark for reviewing the manuscript and precious suggestions.

Literature cited

- Bailey JA, Jeger MJ. 1992. *Colletotrichum*: Biology, pathology and control. Wallingford: CAB International, United Kingdom.
- Brown AE, Soepena H. 1994. Pathogenicity of *Colletotrichum acutatum* and *C. gloeosporioides* on leaves of *Hevea* spp. *Mycol. Res.* 98: 264-266.
- Farr DF, Aime MC, Rossman AY, Palm ME. 2006. Species of *Colletotrichum* on Agavaceae. *Mycol. Res.* 110: 1395-1408.
- Nirenberg UF, Helgard I, Hagedorn G. 2002. Description of *Colletotrichum lupini* comb. nov. in modern terms. *Mycologia* 94: 307-320.
- Lumyong S, Thongantha S, Lumyong P, Tomita F. 2000. Endophytic fungi from 13 bamboo species in Thailand. *Biotechnology for Sustainable Utilization of Biological Resources in the Tropics* 14: 96-101.
- Lubbe CM, Denman S, Cannon PF, Groenewald JZ, Lamprecht SC, Crous PW. 2004. Characteristics of *Colletotrichum* species associated with diseases of Proteaceae. *Mycologia* 96: 1268-1279.
- Lu G, Cannon PF, Reid A, Simmons CM. 2004. Diversity and molecular relationships of endophytic *Colletotrichum* isolates from the Iwokrama Forest Reserve, Guyana. *Mycol. Res.* 108: 53-63.
- McGarvey P, Kaper JM. 1991. A simple and rapid method for screening transgenic plants using the PCR. *Biotechniques* 11: 428-32.
- Moriwaki J, Sato T, Tsukiboshi T. 2003. Morphological and molecular characterization of *Colletotrichum boninense* sp. nov. from Japan. *Mycoscience* 44: 47-53.
- Nakamura M, Ohzono M, Iwai H, Arai K. 2006. Anthracnose of *Sansevieria trifasciata* caused by *Colletotrichum sansevieriae* sp. nov. *J. Gen. Plant Pathol.* 72: 253-256.
- Photita W, Taylor PWJ, Ford R, Hyde KD, Lumyong S. 2005. Morphological and molecular characterization of *Colletotrichum* species from herbaceous plants in Thailand. *Fungal Diversity* 18: 117-133.
- Sutton BC. 1980. The coelomycetes. 523-537. Kew: Commonwealth Mycological Institute, England.
- Sreenivasaprasad S, Brown AE, Mills PR. 1992. DNA sequence variation and interrelationship among *Colletotrichum* species causing strawberry anthracnose. *Physiol. Mol. Plant Pathol.* 41: 265-281.

- Swofford DL. 1998. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The CLUSTAL windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Res.* 24: 4876-4882.
- White TJ, Bruns TD, LEE SB, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. pp. 315-322 in: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds). *PCR Protocols: a Guide to Methods and Applications*. Acad. Press. San Diego, CA.

Additions to the lichen mycota of Iran from East Azerbaijan Province

MOHAMMAD SOHRABI¹ & VAGN ALSTRUP²

mohammad.sohrabi@helsinki.fi

¹*Botanical Museum (Mycology)*

P. O. Box 7, FI-00014 Helsinki University, Finland

vagna@snm.ku.dk

²*Botanical Museum, University of Copenhagen*

Gothersgade 130, DK-1123 Copenhagen K, Denmark

Abstract—This paper reports 48 species of lichens and 30 lichenicolous fungi new to Iran originating from Arasbaran (Gharadaq) in the Province East Azerbaijan in northwestern Iran. The complete list of record can be downloaded online from <http://www.mycotaxon.com/resources/weblists.html>.

Key words— Arasbaran forests, lichenized mycota, new records

Introduction

The preliminary lichen checklist of Iran (Seaward et al. 2004) included 396 lichens and 8 lichenicolous fungi based on literature records and study of voucher material. It also summarized the literature on Iranian lichens. A study of the Golestan National Park, NE Iran (Sohrabi & Sipman, in prep.) yielded another 14 species to the list. This paper reports new collections from the Arasbaran area, East Azerbaijan Province in NW Iran, all new reports to Iran. Other papers from Arasbaran deal with *Cladonia* (Ahti & Sohrabi 2006), *Lepraria* (Sohrabi & Orange 2006), *Peltigera* (Sohrabi & Vitikainen, in prep.), *Candelariella* (Westberg & Sohrabi, in prep.) and *Caloplaca* (Söchting & Sohrabi, in prep.), all adding several new species to the list of Iranian lichens.

The Arasbaran Biosphere Reserve is located in the northwest of Iran bordering the republics Azerbaijan and Armenia ~90 km northeast of Tabriz (Fig. 1). The 164 000 ha area features high mountains, deep valleys, steep slopes, dense forests and vast rangeland. Elevations range from a high of 1500 m in the semi-arid steppic foothills in the south and ~2800 m in the alpine central mountains to the low ~700 m of the Aras River valley in the north. Moisture-laden winds from the Caspian Sea support a rather isolated patch of deciduous

forest up to c. 2000 m, an outlier of extensive forests further north, and lush alpine meadows above the tree line. Access to the Reserve has remained difficult because of the absence of all-weather roads. Land ownership is public. Large areas of forest have been cleared for cereal and vegetable crops, orchards, and pastureland, and much of the remaining forest has been degraded by grazing and cutting of fuel wood.

The reserve is influenced by three different climatic zones: the cold and semi-arid Irano-Turanian region (loc. I) to the south, the subtropical (sub) humid and relatively warm central montane Saigiram daq and south-eastern Talish region and Hyrcanian belt (locs. V and VI), and the relatively cold and sub-humid Mediterranean climates found in the west and north (locs. II-IV and VII). Such varying climate regimes favor different ecosystem types and ~1000 plant species; there are 140 woody plant species, of which the most prominent are *Quercus macranthera*, *Juniperus communis*, *Pistacia atlantica*, *Carpinus betulus*, *Fraxinus rotundifolia*, and *Acer campestre*.

Materials and methods

Materials were collected by Sohrabi in 2001, 2004 and 2005, aided by Masoomeh Ghobadnejhad at loc. III. The authors examined the collections under the microscope and with usual test reagents during the second author's stay at the Botanical Museum of Helsinki in August 2006. Nomenclature follows Santesson et al. (2004) when possible. All specimens are stored in Herbarium Sohrabi; selected duplicates are curated in H and C.

Results

The authors identified 48 species of lichens and 30 lichenicolous fungi not previously reported from Iran, all collected from seven different sites (see Fig. 1) located within the Arasbaran (Gharadaq) Bioserve Area in the East Azerbaijan Province, in northwestern Iran. The 56 genera represented include *Abrothallus* (1), *Arthonia* (3), *Arthrorhaphis*, *Bryoria*, *Buellia*, *Caloplaca*, *Catapyrenium*, *Catillaria*, *Cetraria* (2), *Chaenotheca*, *Clypeococcum*, *Dactylospora*, *Dermatocarpon*, *Echinothecium*, *Endocarpon*, *Endococcus*, *Fuscopannaria*, *Lecania*, *Lecanora* (4), *Lecidea*, *Lecidella*, (2), *Leptogium* (2), *Lichenocodium* (2), *Lichenostigma* (2), *Lobaria*, *Marchandiomyces*, *Muellerella*, *Mycobilimbia* (2), *Opegrapha*, *Pachyphiale*, *Parmeliella*, *Phaeosporobolus* (2), *Physcia*, *Physconia* (3), *Polycoccum*, *Pronectria*, *Protopannaria*, *Protothelenella*, *Psilolechia*, *Raciborskiomyces*, *Ramalina*, *Rhizoplaca*, *Rimularia*, *Rinodina* (2), *Rosellinula*, *Scoliciosporum*, *Sphaerellothecium*, *Staurothele*, *Stigmidium* (5), *Thelenella*, *Toninia*, *Tremella*, *Umbilicaria* (4), *Verrucaria*, and *Xanthoriicola*. Of the widespread species not previously reported *Cetraria islandica* (L.) Ach. subsp. *islandica*, *Chaenotheca furfuracea* (L.) Tibell and *Umbilicaria vellea* (L.)

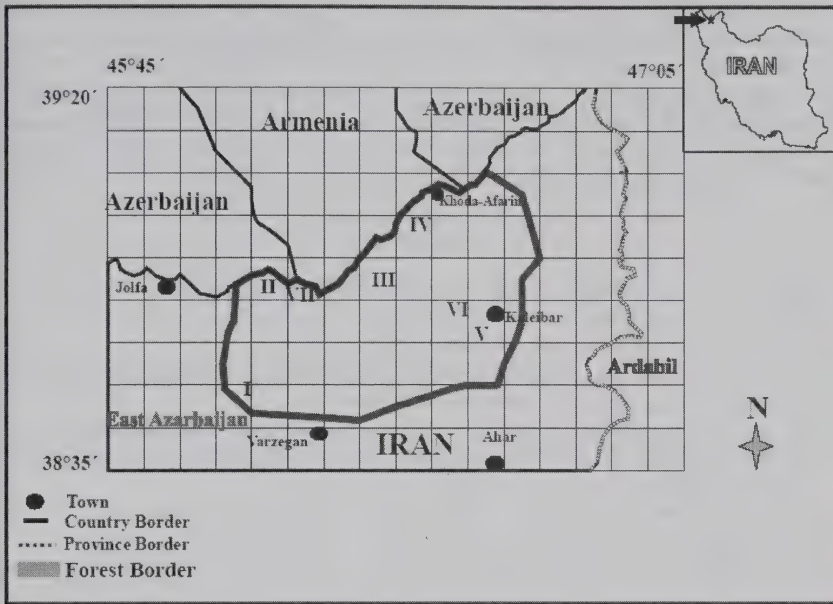


Fig.1- 2001–2005 lichen and lichenicolous fungal collection sites in Arasbaran Biosphere Reserve (East Azerbaijan Province, northwest Iran). I- Varzegan, ca. 26 km west of Varzegan and ca. 6 km east of Joshin village (Kharvana), Joshin Castle, 1700–2000 m, 46°21'N, 38° 39'E., 18.07.2005. II- Jolfa, Jolfa to Khoda-afarin, 5 km from the south of road, Missan village, 1000–1500 m, 15.7.2001. III- Kaleibar, 21 km south of the road of Khoda-afarin to Jolfa, Aynaloo, 1700–1900 m, 38°50'03"E, 46°47'29"N, 20.08.2005. IV- Kaleibar, ca. 10 km south of Aras River and the road Khoda-afarin to Jolfa, Dar-Aghzi village, 39°05'E, 46°53'N, 450 m., 19.08.2005. V- Kalibar, ca. 4 km SW of Kalibar, Galadarasi, toward Babak Castle (Bez Galasi), 1750–2500 m, 38°52'07"E, 46°58'06"N; 19.08.2005. VI- Kalibar, ca. 10 km west of Kalibar, Hejrandoost village, 1750–1850 m, 38°52'07"E, 46°58'06"N, 20.08.2005. VII- Jolfa, Arasbaran, the road of Khoda-afarin to Jolfa, crossing at Uoshtipin village road, Hrass, 500 m, road side lichens, 20.07. 2004.

Hoffm. were the most commonly encountered new species. *Catillaria chalybeia* (Borrer) A. Massal. represents species known previously only from one or two reports.

The full report, which provides substrate, site, and collection data for each species, is available online from <http://www.mycotaxon.com/resources/weblists.html>.

Acknowledgements

The authors express their gratitude to Prof. Teuvo Ahti (Helsinki) and Dr. Orvo Vitikainen (Helsinki) for their advice and critical reading of the manuscript and Dr. Leena Myllys (Helsinki) for her help in identifying some Bryoria specimens and Dr

Harrie Sipman (Berlin), for help in identifications of *Umbilicaria* specimens. The first author acknowledges the help by Ms. Masoomah Ghobadnejhad (Helsinki) during field work, and Prof. Jaakko Hyvönen (Helsinki) for his encouragement. The cost of the field work was covered by Mr. Rostam Sohrabi (Jolfa, Iran), and the Iranian Ministry of Science granted a scholarship to the first author for studying at Botanical Museum, University of Helsinki. The second author's visit to Helsinki was paid by a grant from the Nordic Council of Ministers.

Literature cited

- Ahti T, Sohrabi M. 2006. Synopsis of Iranian *Cladonia* (lichens). *Flora Mediterranea* 16: 139-144.
- Clauzade G, Diederich P, Roux C. 1989. Nelikenigintaj fungoj likenlogaj. *Bulletin de la Société Linnéenne de Provence, Numero Spécial* 1: 1-142.
- Clauzade G, Roux C. 1985. Likenoj de Okcidenta Eurupo. *Bulletin de la Société Botanique du Centre-Ouest, Nouvelle série, Numero Spécial* 7:1-893.
- Esslinger TL. 2006. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. Fargo, North Dakota State University: [<http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm>].
- John V, Seaward MRD, Sipman HJM, Zedda L. 2004. Lichens and lichenicolous fungi of Syria, including a first checklist. *Herzogia* 17: 157-177.
- Kärnefelt I. 1979. The brown fruticose species of *Cetraria*. *Opera Botanica* 46: 1-150.
- Santesson R, Moberg R, Nordin A, Tønsberg T, Vitikainen O. 2004. Lichen-forming and lichenicolous fungi of Fennoscandia. *Museum of Evolution, Uppsala*, 359 pp.
- Seaward MRD, Sipman HJM, Schultz M, Maassoumi AA, Anbaran MHM, Sohrabi M. 2004. A preliminary lichen checklist for Iran. *Willdenowia* 34: 543-576.
- Sohrabi M, Orange A. 2006. New records of sorediate lichens from Iran. *Iranian Journal of Botany* 12: 103-105.
- Triebel D, Rambold G, Nash TH. 1991. On lichenicolous fungi from North America. *Mycotaxon* 42: 263-296.

Taxonomic studies of *Pseudospiropes* from Yunnan, China

ZHI-QIANG SHANG² & XIU-GUO ZHANG^{1*}

zhxg@sdaa.edu.cn

¹Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

²Yunnan Province Tobacco Science Research Institute
Yunnan, Yuxi, 653100, China

Abstract—Two new species of *Pseudospiropes* from dead branches are described and illustrated. They are *P. ximeniae* and *P. mussaendae*, saprophytes of *Ximenia* and *Mussaenda erosa*, respectively. Three new records are noted from the same area.

Key words—hyphomycetes, dematiaceous

Introduction

The genus *Pseudospiropes* was established by Ellis (1971), who precisely defined the distinctive features of this genus. *Pseudospiropes* is characterized by polyblastic, integrated, terminal (sometimes becoming intercalary, sometimes geniculate) cicatrized sympodially extending conidiogenous cells on unbranched conidiophores that often have dark, conspicuous large scars, and fusiform, navicular or obclavate, solitary conidia (usually with transverse pseudosepta or eusepta). These characters separate this genus from the similar *Helminthosporium* Link and *Pleurophragmium* Costantin.

The genus *Pseudospiropes* contains 31 species described from all over the world. Most species reportedly survive on plant leaves, but some species occur as saprophytes on dead branches. Until now, no *Pseudospiropes* species has been described from China.

This study proposes two new *Pseudospiropes* species discovered on dead branches from subtropical forests in Yunnan Province of China. Three other species new to China are also reported.

*Corresponding author

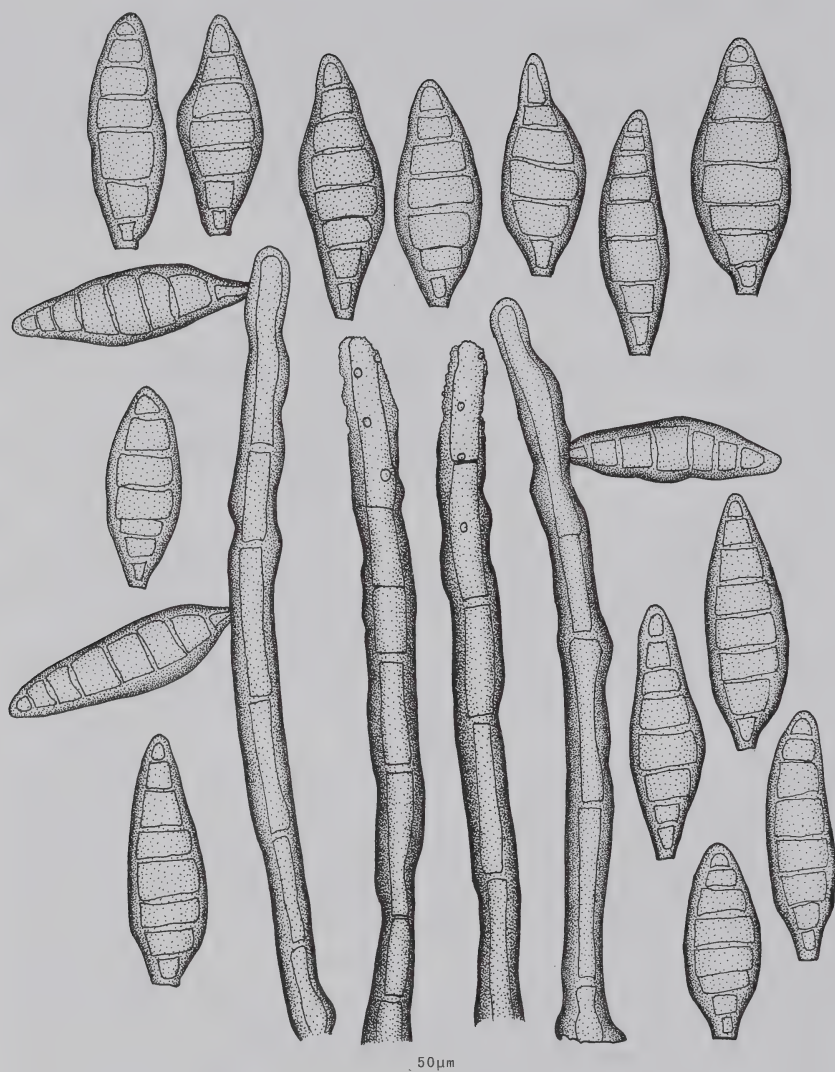


Fig. 1 Conidia and conidiophores of *P. ximeniae*

Taxonomic Description

Pseudospiropes ximeniae Zh.Q. Shang & X.G. Zhang, sp. nov.

MYCOBANK MB 510610

Coloniae effusae, olivaceo-brunneae vel fuscae, velutinae vel pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus,

FIGURE 1

1.5-2.5 µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel caespitosa, erecta, recta vel flexuosa, 5-9-septata, levia, simplicia, pallide brunnea, sursum brunnea, 120-163 µm longa, 6.0-7.0 µm crassa. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, cylindricae, plurimae cicatricibus claris, planis, modice inspissatis praeditae. Conidia solitaria, sicca, acropleurogena, simplicia, fusiformia vel navicularis, basi truncata, pallide brunnea, laevia, 6-8-pseudoseptata, 29-40 µm longa, 12-14 µm crassa, basi truncata 2.0-3.0 µm lata.

Holotype: on dead branches of *Ximenia* L., Kunming, Yunnan Province, China. Sept. 8. 2003, X. G. Zhang, HSAUPIII₀ 0361-2 (isotype: HMAS 143717).

Etymology: in reference to the host, *Ximenia*

Colonies effuse, olivaceous brown to dark blackish brown, velvety or hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, pale brown, smooth walled hyphae, 1.5-2.5 µm thick. Conidiophores macronematous, mononematous, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, pale brown, paler toward the apex, 5-9-septate, 120-163 × 6.0-7.0 µm. Conidiogenous cells polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, bearing a number of thin, flat, small, slightly thickened, pale, very slightly protruding scars. Conidia solitary, dry, acropleurogenous, simple, fusiform to navicular, base narrowly truncate, pale brown, smooth, 6-8-pseudoseptate, 34-40 µm long, 12-14 µm thick, 2.0-2.8 µm wide at the truncate base.

The conidia of *Pseudospiropes ximeniae* are similar to those of *P. simplex* (Ellis 1971) and *P. hachijoensis* (Matsushima 1975). However, the conidia of the new taxon are wider than those of *P. simplex* (9-12 µm) and *P. hachijoensis* (8-10 µm). In addition, the conidia of the new species have only 6-8 pseudosepta, while those of *P. simplex* have 6-11, and the conidial bases of the new taxon are narrower than those of *P. simplex* (3-4 µm) and *P. hachijoensis* (3.3-3.8 µm).

***Pseudospiropes mussaendae* Zh.Q. Shang & X.G. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 510611

Coloniae effusae, brunneae vel fuscae, velutinae vel pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus, 2.0-2.5 µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel caespitosa, erecta, recta vel flexuosa, 8-10-septata, levia, simplicia, pallide brunnea, sursum brunnea, 145-190 µm longa, 6.0-7.0 µm crassa. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, cylindricae, plurimae cicatricibus claris, planis, modice inspissatis praeditae. Conidia solitaria, sicca, acropleurogena, simplicia, fusiformia vel obclavata, basi truncata, pallide brunnea, laevia, 8-9-pseudoseptata, 36-47 µm longa, 9-11 µm crassa, basi truncata 2.7-3.2 µm lata.

Holotype: on dead branches of *Mussaenda erosa* Champ., Kunming, Yunnan Province, China. Sept. 7. 2003, X. G. Zhang, HSAUPIII₀ 0046-1 (isotype: HMAS 143718).

Etymology: in reference to the host, *Mussaenda erosa*

Colonies effuse, olivaceous brown to dark blackish brown, velvety or hairy.

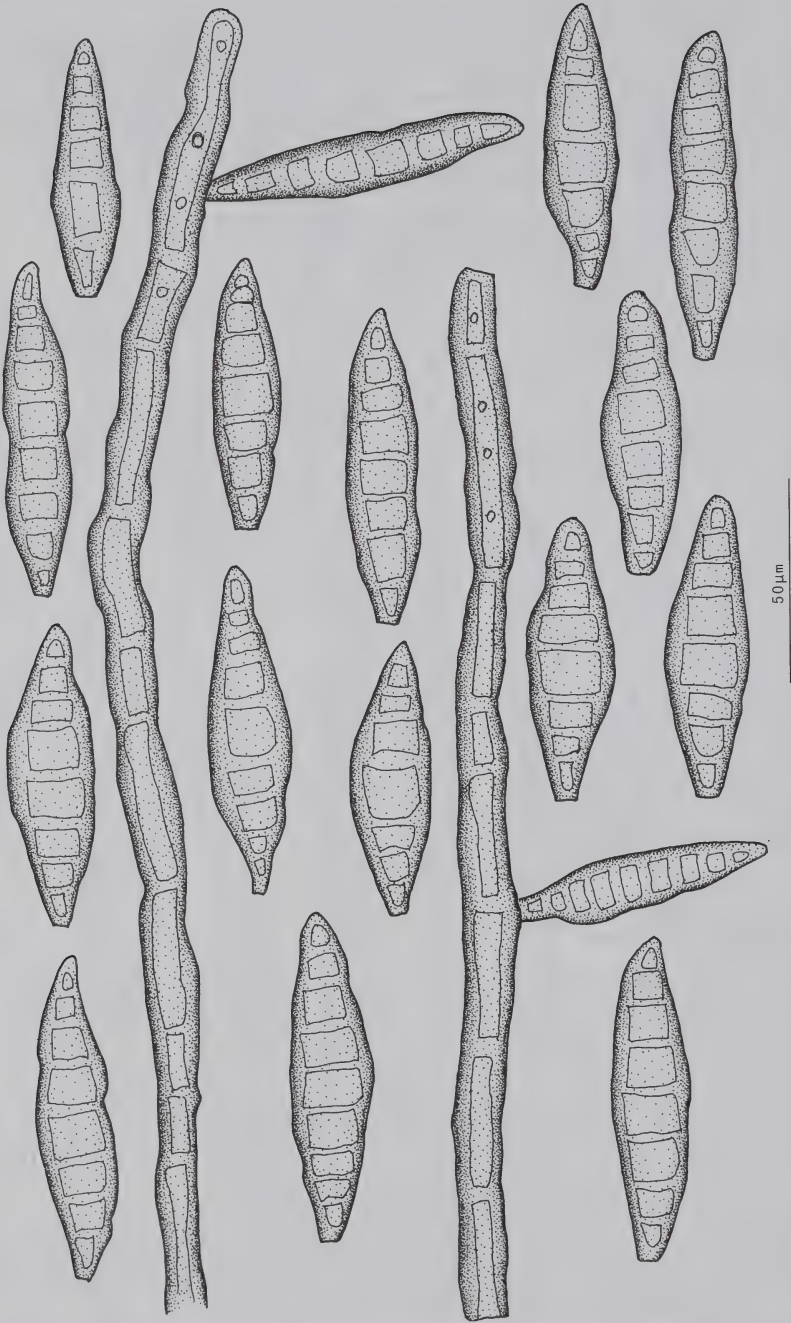


Fig. 2 Conidia and conidiophores of *P. mussaendae*

Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, pale brown, smooth walled hyphae, 2.0-2.5 μm thick. Conidiophores macronematous, mononematous, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, pale brown, paler toward the apex, 8-10-septate, 145-190 $\times$ 6.0-7.0 μm . Conidiogenous cells polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, bearing a number of thin, flat, small, slightly thickened, pale, very slightly protruding scars. Conidia solitary, dry, acropleurogenous, simple, fusiform to obclavate, base narrowly truncate, pale brown, smooth, 8-9-pseudoseptate, 36-47 μm long, 9-11 μm thick, 2.7-3.2 μm wide at the truncate base.

The conidia of *Pseudospiropes mussaendae* are similar to those of *P. rousselianus* (Ellis 1976) and *P. hachijoensis* (Matsushima 1975), but their size range is larger than that of *P. rousselianus* (20-37 $\times$ 5-8 μm) and *P. hachijoensis* (30-40 $\times$ 8-10 μm). In addition, the conidia in *P. mussaendae* have 8-9 pseudosepta compared to conidia with 6-7 pseudosepta in *P. hachijoensis*. In contrast, the conidia of *P. rousselianus* have only 3-7 septa and are not pseudoseptate.

New records from China

Pseudospiropes dumeti Lunghini & Pinzari, 1996, Mycotaxon 58: 343.

On dead branches of *Mangifera indica* L., Kunming, Yunnan Province, China. Sept. 7. 2003, X. G. Zhang, HSAUPIII₀ 0055.

Pseudospiropes simplex (Kunze) M.B. Ellis, 1971, Dematiaceous Hyphomycetes:260.

On dead branches of *Michelia champaca* L., Kunming, Yunnan Province, China. Sept. 8. 2003, X. G. Zhang, HSAUPIII₀ 0628.

Pseudospiropes lotorum Morgan-Jones, 1977, Mycotaxon 5: 481.

On dead branches of *Photinia serrulata* Lindl., Kunming, Yunnan Province, China. Sept. 9. 2003, X. G. Zhang, HSAUPIII₀ 0534.

Acknowledgments

The authors are indebted to W.B. Kendrick and N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30370009, 30499340).

Literature cited

- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
Ellis MB. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
Matsushima T. 1975. Icones Microfungorum a Matsushima Lectorum. Kobe. Japan.

Two new *Corynespora* species from Jiangsu, ChinaZHI-QIANG SHANG² & XIU-GUO ZHANG^{1*}

zhxg@sdaa.edu.cn

¹Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China²Yunnan Province Tobacco Science Research Institute
Yunnan, Yuxi, 653100, China

Abstract—This paper provides descriptions and illustrations of two new species in the hyphomycete genus *Corynespora* from dead branches. *C. merrillioanacis* and *C. micheliae* survive saprophytically on *Merrillioanax listeri* and *Michelia champaca*, respectively.

Key words—hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on dead branches from south of China revealed two previously undescribed species of *Corynespora* Güssow (1906). These two species were collected from the Nanjing Arboretum in Jiangsu Province.

Taxonomic Description

Corynespora merrillioanacis Zh.Q. Shang & X.G. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 510612

Coloniae fuscae, velutinae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, levibus, 3.5–4.0 µm crassis compositum. Stromata nulla. Conidiophora fasciculata, erecta, simplicia, recta vel flexuosa, pallide brunnea vel brunnea, septata, per usque ad 5 proliferationes successivas cylindricas elongascentia, 260–1200 µm longa, 12–17 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevia, straminea vel brunnea, 12–25-pseudoseptata, 130–260 µm longa, 17–21 µm crassa, basi truncata 7–8 µm lata.

Holotype: on dead branches of *Merrillioanax listeri* (King) Li, Arboretum of Nanjing, Jiangsu Province, China. Sept. 8. 2003, X. G. Zhang, HSAUP III₀ 0946 (isotype: HMAS 143713).

Etymology: in reference to the host, *Merrillioanax listeri*

*Corresponding author

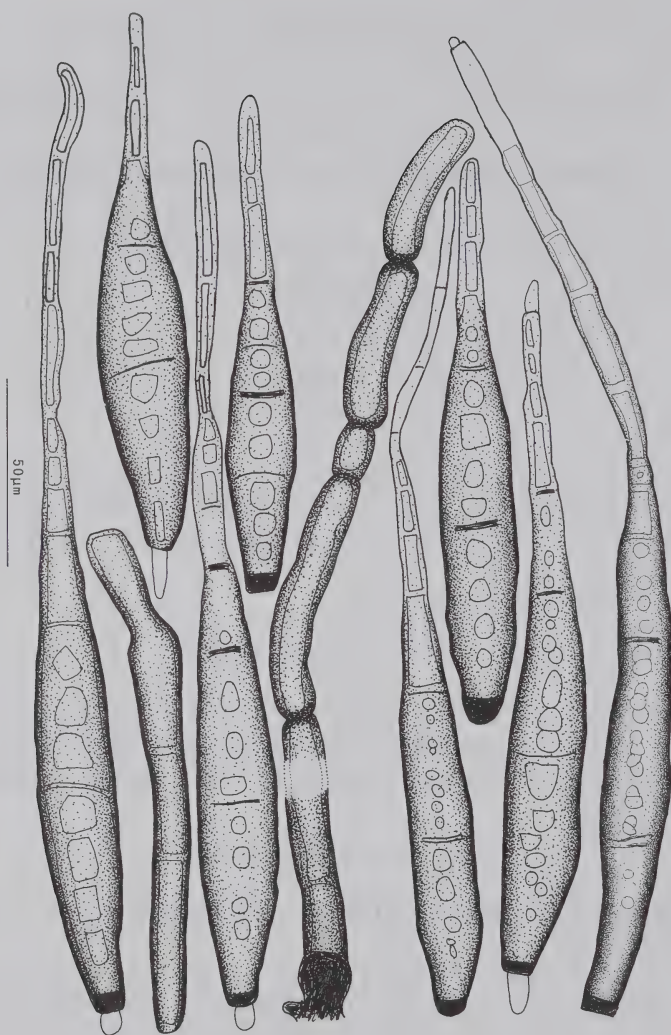


Fig. 1 Conidia and conidiophores of *C. merrilliopanis*

Colonies dark blackish brown, velvety, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth walled hyphae, 3.5-4.0 μm thick. Stroma absent. Conidiophores fasciculate, erect, simple, straight or flexuous, pale brown to brown, septate, with up to 5 successive cylindrical proliferations, 260-1200 $\times$ 12-17 μm . Conidia formed singly through a pore at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at

the apex of the proliferation, straight or curved, obclavate, tapering to the apex, smooth, straw coloured to brown, 12-25-pseudoseptate, 130-260 μm long, 17-21 μm thick, 7-8 μm wide at the truncate base, lower cells darker brown, upper cells becoming gradually paler toward the apex.

The new species differs from *C. leptoderridicola* (Ellis 1957) in its conspicuously larger conidia. In addition, the conidia of the new species have 12-25 pseudosepta, while those of *C. leptoderridicola* have only 6-16.

Corynespora micheliae Zh.Q. Shang & X.G. Zhang, sp. nov.

FIGURE 2

MYCOBANK MB 510613

Coloniae griseae vel fuscae, velutinae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, levibus, 3.0-3.5 μm crassis compositum. Stromata nulla. Conidiophora fasciculata, erecta, simplicia, recta vel flexuosa, brunnea, septata, per usque ad 3 proliferationes successivas cylindricas elongascentia, 190-210 μm longa, 9-10 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, laevia, subhyalina vel brunnea, fere obclavata longe attenuata, recta vel curvata, 12-28-pseudoseptata, 333-360 μm longa, 15-19 μm crassa, basi truncata 7-8 μm lata.

Holotype: on dead branches of *Michelia champaca* L., Arboretum of Nanjing, Jiangsu Province, China. Sept. 9. 2003, X. G. Zhang, HSAUPIII₀ 0928-2 (isotype: HMAS 143714).

Etymology: in reference to the host, *Michelia champaca*

Colonies grey to dark blackish brown, velvety, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 3.0-3.5 μm thick. Stroma absent. Conidiophores fasciculate, erect, simple, straight or flexuous, brown, septate, with up to 3 successive cylindrical proliferations, 190-210 $\times$ 9-19 μm . Conidia formed singly through a pore at the apex of the conidiophore, which then proliferates through the pore and forms another conidium at the apex of the proliferation, smooth walled, subhyaline coloured to brown, usually obclavate tapering to the narrow apex, straight or curved, 12-28-pseudoseptate, 333-360 μm long, 15-19 μm thick, 6-7 μm wide at the truncate base, lower cells darker brown, upper cells becoming gradually paler toward the apex.

This species resembles *C. leptoderridicola* (Ellis 1957). However, the conidia of the new taxon are longer than those of *C. leptoderridicola* (70-120 μm). In addition, the conidia of the new taxon have 18-28 pseudosepta, while those of *C. leptoderridicola* have only 6-16 pseudosepta.

Acknowledgments

The authors are indebted to W.B. Kendrick and N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (no. 30370009, 30499340).



Fig. 2 Conidia and conidiophores of *C. micheliae*

Literature cited

- Güssow HT. 1906. Über eine neue Krankheit an Gurken in England. Z. Pflkrankh. 16 : 10-13.
Ellis MB. 1957. Some species of *Corynespora*. Mycological papers 65 : 1-15.

Two new species of *Alternaria* from pear fruit

RODNEY G. ROBERTS

roberts@tfrl.ars.usda.gov

USDA, ARS, Tree Fruit Research Laboratory

1104 N. Western Ave., Wenatchee, WA 98801

Abstract— Two new taxa in *Alternaria* are here described as *A. calycipyricola* from the calyces of fruits of *Pyrus communis* ‘d’Anjou’ grown in Washington State, and *A. ventricosa* from the stem of a fruit of *Pyrus bretschneideri* ‘Ya Li’ grown in Hebei, China. Conidia of both species are fundamentally erostrate but may produce elongate apical secondary conidiophores from which chain elongation and lateral branching occur late in the development of individual conidia. *A. calycipyricola* and *A. ventricosa* differ from each other in cultural characters, growth rate, and conidial morphology. Combined analyses of RAPD, RAMS and AFLP fingerprints support morphological evidence that *A. calycipyricola* and *A. ventricosa* are appropriately placed in the *A. infectoria* species-group sensu Simmons and are distinct from each other and the other species studied within the group.

Key words— *Alternaria alternata*

Introduction

The rationale for this paper extends well past a decade to 1990 when I had the pleasure of traveling through fruit production areas on Honshu with EG Simmons to collect plant material from Japanese pear orchards infected with black spot disease. Our purpose was to clarify the identity of the *Alternaria* incitant of black spot disease (at that time referred to as *A. kikuchiana* S. Tanaka or, incorrectly, as *A. alternata* ‘Japanese pear pathotype’) by experimentally testing the hypothesis posed some years earlier by Nishimura (1978) that the black spot pathogen had a similar range of spore sizes with *A. alternata*, and if other characters were lacking to distinguish it from *A. alternata*, it should be treated as a synonym of the earlier name *A. alternata*. This hypothesis was tested in a double-blind experiment reported by Simmons & Roberts (1993). Simmons, without prior knowledge of the toxigenicity or pathogenicity of the isolates studied, was able to select from among a large set of environmental isolates those strains which were independently demonstrated to produce AKT toxins and black spot lesions on detached 20th Century Japanese pear leaves with a high degree of accuracy based upon the pattern of sporulation

observable at 50X magnification, thereby disproving Nishimura's hypothesis. This result opened my eyes and mind to the benefits of a structured study of *Alternaria*, and to the fact that small but consistent differences, often dismissed as intraspecific variability, are indeed important indicators with taxonomic value that can and should be used to characterize new taxa when appropriate.

Such work to isolate and characterize the *Alternaria* incitants of plant diseases of economic importance has continued into the present. During the intervening years, occasional isolates of *Alternaria* have come to hand for which there are no appropriate descriptions or names in the literature. A number of such isolates have been set aside but preserved for description at a later time. This paper is the first in a series of papers whose purpose is to provide descriptions and names for those strains of *Alternaria*. As these new taxa are documented, it is hoped that a new and deeper understanding of the species diversity of *Alternaria* species that inhabit fruit and other substrates will be gained and that subsequent decisions, whether they are for disease control measures or regulatory action, will be made from a more informed position than is currently possible.

Materials and methods

Conditions of isolation, culture and observation. The media, methods and conditions for growth and observation of *Alternaria* follow those described in pages 136-137 in Simmons & Roberts (1993). All isolates that represent newly described species in this paper were obtained from fruit of *Pyrus* spp. RGR 96.0209 and RGR 96.0210 were isolated by removing bits of visible white mycelium observed in the calyx of several stored *Pyrus communis* L. 'd'Anjou' pear fruit and placing them onto plates of potato carrot agar (PCA). RGR 04.0031 and RGR 04.0032 were obtained from the stem tissues of *Pyrus bretschneideri* Rehder 'Ya Li' pear fruit purchased from a retail display in a grocery store chain. Stems were swabbed with 70% ethanol then stem slices were removed with a sterile scalpel blade and placed onto PCA. In both instances, isolation plates were held at approx. 25C under cool white fluorescent lighting (8 hr/16 hr of light/dark) until sporulation was evident, and then conidia were transferred to fresh PCA or V8 juice agar plates. Cultures were preserved by lyophilization and by refrigerated storage of small blocks of agar cut from the leading edge of cultures and placed into tubes of sterile water. Color references in the taxonomic descriptions refer to the corresponding color plates in the Methuen Handbook of Colour (Kornerup & Wanscher 1989).

Molecular analysis. Cultures were grown and DNA prepared for analysis by the methods reported previously (Roberts et al. 2000). Methods and conditions for randomly amplified polymorphic DNA (RAPD) analyses followed Roberts

et al., 2000. Randomly amplified microsatellite (RAMS) fingerprints were produced according to the method reported in Hantula & Müller (1997), and amplified fragment length polymorphism (AFLP) fingerprints were produced using the AFLP Analysis System For Microorganisms according to the vendor instructions (Invitrogen Life Technologies, Carlsbad, CA) except genomic DNA was extracted using a CTAB protocol and WellRED fluorescent dye D2-PA (Proligo LLC, Boulder, CO) was used to label the EcoR1 primers *in lieu* of ^{32}P so that a Beckman Coulter CEQ 8000 Genetic Analysis System could be used for fragment resolution. All fingerprint types for RGR 96.0209, 96.0210, 04.0031, 04.0032 and 160 additional isolates representing a wide range of authenticated, unidentified, and ex-type strains of diverse geographic and host origins were analyzed concurrently as different 'experiment' types using experiment averaging and the Ward algorithm for cluster analysis in BioNumerics 4.61 software (Applied Maths, Gent, Belgium).

RAPD fingerprints were generated as in Roberts et al. (2000) using three decameric oligonucleotide primers; OPR-02 ($^5\text{CACAGCTGCC}^3$), OPR-08 ($^5\text{CCCGTTGCCT}^3$) and OPR-12 ($^5\text{ACAGGTGCGT}^3$). Two replicate fingerprints produced for each isolate were digitized and imported into BioNumerics software. Band selection reflected a consensus fingerprint of both trials. All consensus banding patterns were normalized to one reference DNA ladder and then band similarities between isolates were calculated using a binary band-based coefficient (Dice). Band position tolerance settings were 1% optimization, 1% position tolerance, with minimum band height and minimum surface set at 0%.

RAMS fingerprints were generated following the method of Hantula (1997) using two primers, DDB(CCA)₅ and DHB(CGA)₅. RAMS fingerprint analysis followed the protocol described above for RAPD fingerprints.

AFLP fingerprints were generated using an Invitrogen AFLP Core Reagent Kit and AFLP Microorganism Primer Kit according to the manufacturer's instructions except that ^{32}P was not used. An AFLP primer labeled with the WellRED fluorescent dye D2-PA (Proligo) was substituted for the ^{32}P -labeled or ^{33}P -labeled EcoR1 primer specified in the Invitrogen protocol and the AFLP amplicons were resolved and analyzed using an 8-lane capillary DNA sequencer (CEQ 8000 Genetic Analysis System) and the associated Fragment Analysis module. The WellRED labeled primer was EcoR1AA-D2 (5'-(dyeD2) GACTGCGTACCAATTCAA-3'). Maximum bin width was one (1), fully populated bins and samples without qualifying peaks were excluded, with the Y-threshold set to zero (0). The resulting analysis was exported to BioNumerics and analyzed using the same consensus band similarity methods and quality criteria as RAPD and RAMS fingerprints.



Fig. 1. Conidia of *A. calycipyricola* from V8 juice agar. Bar = 50 µm

A combined similarity matrix was calculated from the consensus RAPD, RAMS and AFLP matrices in BioNumerics, with the data treated as a composite data set and a combined similarity matrix calculated as the average from all experiments (fingerprints), obviating the need to assign weights to each fingerprint type. The Ward algorithm was used for dendrogram generation.

Taxonomic description

Alternaria calycipyricola R.G. Roberts, sp. nov.

Figs. 1, 2

MYCOBANK MB 510583

Etym.: *calyx* - calyx; + *pyrus* - pear; + *-cola* - living upon

Ex cultura in agaro V-8 post 7 dies descripta. Colonia ca. 25 mm diam., diffuse concentricè zonata. Conidiophora ad 20-175 x 4-7 µm, ex hyphis funiculosi aerii, interdum geniculata. Conidia 24-83 x 9-28 µm, erostrata, solitaria vel catenata ope conidiophorum secundariorum, obclavata, ovoidea vel cylindrica ellipsoideaque, laevia vel minute verruculosa, pallide brunnea, compluries inaequilatera ob cellulas laterales tumidas, transverse 6-12 septata, septis longitudinalibus obliquisque aliquantibus.

Description from cultures grown on V8 juice agar for 7 days at 25°C and 21% RH. Colonies slow-growing, becoming about 25 mm diam. at 7 days, concentrically zonate but diffuse due to sparse sporulation. Areas developed during light

exposure low, initially white to grayish white (1B1), darkening slightly with age to a medium gray (1E1). Areas developed during dark period produce relatively more aerial hyphae. Primary conidiophores are $20\text{--}175 \times 4\text{--}7 \mu\text{m}$, usually produced from tortuous aerial elements that may become funiculose with age and bear short, branching chains of 3-4 conidia, often becoming geniculate from successive extension (renewal of growth) of the secondary conidiophore. Conidia smooth to minutely verruculose, hyaline when young, becoming pale brown (6E8) with age but remaining translucent, $24\text{--}83 \times 9\text{--}28 \mu\text{m}$, erostrate, solitary or catenulate via sympodial development of apical, lateral and basal secondary conidiophores that may be up to $90 \times 7 \mu\text{m}$. Conidia obclavate to ovoid when young, with age becoming nearly cylindrical to ellipsoidal and often irregular in outline and shape due to proliferation of intercalary cells. Stromatic bodies up to $250 \mu\text{m}$ diam. that are assumed to be protoascomata are produced within and upon the agar (Fig. 2). Development of asci within stromata was not observed.

Type (holotype): BPI 872337 (dried culture preparation ex RGR 96.0209, isol. Roberts from moribund calyx elements of *Pyrus communis*, Cashmere, Washington, U.S.A., 1996.

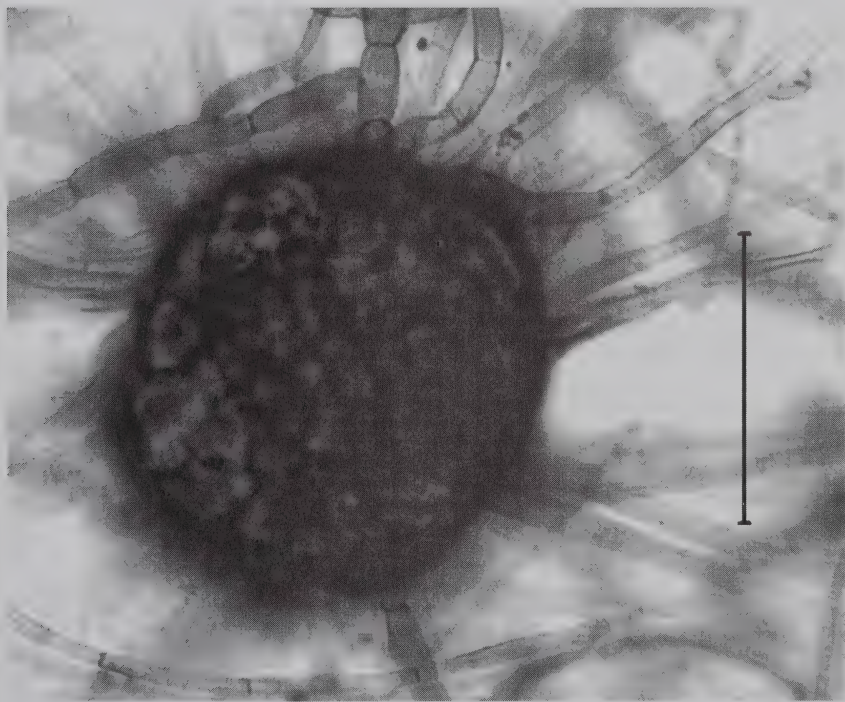


Fig. 2. Putative protoascoma of *A. calycipyricola* from V8 juice agar. Bar = $100 \mu\text{m}$

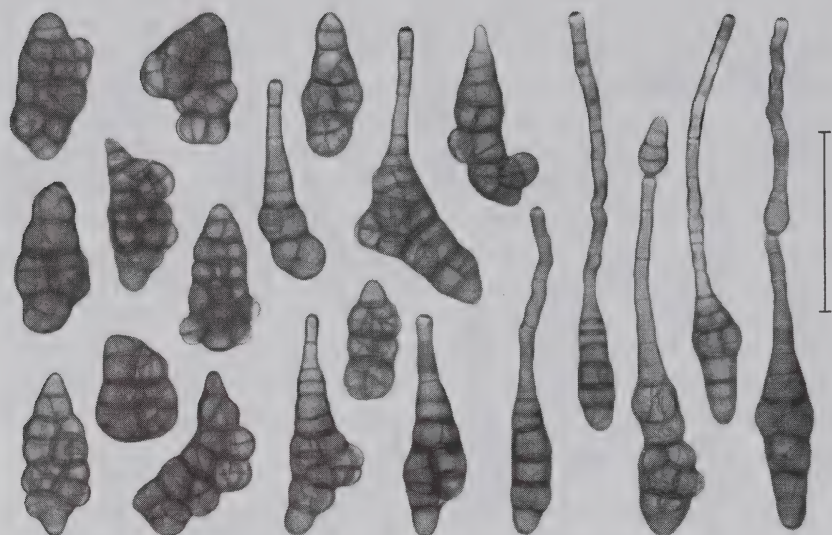


Fig. 3. Conidia of *A. ventricosa* from V8 juice agar, Bar = 50 μ m

***Alternaria ventricosa* R.G. Roberts, sp. nov.**

MYCOBANK MB 510582

Etym.: *ventricosa* – ventricose; markedly swollen, distended or inflated, especially on one side.

Ex cultura in agaro V-8 post 7 dies descripta. Colonia ca. 35 mm diam., concentric zonata. Conidiophora ad 14-420 x 4-7 μ m, ramosa vel eramosa, interdum geniculata. Conidia 16-53 x 9-22 μ m, erostrata, solitaria vel catenata ope conidiophororum secundariorum, ellipsoidea vel late ovoidea, verruculosa vel punctulata, pallide brunnea, compluries inaequilatera ob cellulas laterales tumidas, transverse 6-8 septata, septis longitudinalibus obliquisque aliquidis.

Description from cultures grown on V8 juice agar for 7 days at 25C and 21% RH. Colonies about 35 mm diam., concentrically zonate. Areas developed during light exposure low, granular in appearance from sporulation which is initially light grayish green, near cactus green (28E4), darkening with age to greenish black (27AH). Areas of colony produced during dark period produce abundant aerial hyphae that may become fasciculate with age from which solitary short-catenulate conidia are produced. Color of dark-grown areas similar to but lighter than light-grown areas. Conidiophores arise from agar surface when exposed to light; 14-420 x 4-7 μ m, pale grey by transmitted light but the area adjacent to septa can be without pigment, solitary, branched

Fig. 3

or unbranched, often becoming geniculate from successive production of conidia. Conidia 16-53 x 9-22 μm , erostrate and solitary or short-catenulate, producing short branching chains via sympodial development of a primarily apical secondary conidiophore, although conidiophores can also develop from the basal or (rarely) intercalary cells of the conidium with age. Lateral development of secondary conidiophores from subapical cells is rare. Conidia ellipsoidal to broadly ovoidal, becoming obclavate from apical growth of secondary conidiophores, verruculose to punctulate, translucent, near pale cinnamon brown (6D6). The appearance of juvenile conidia is dominated by one to four (rarely, six) transverse septa, which become darker and constrict the conidium outline with age. Oblique and longitudinal septa are paler than the first transverse septa and develop within the segments defined by the oldest transverse septa. Cells delimited by these paler septa may expand, giving the conidium outline an almost crenate appearance in plane section and may cause the conidium to become curved when expansion is unilateral. Secondary conidiophores usually develop from the conidium apex, and may be short or, in the case of smaller conidia, several times the length of the conidium body. Similar in appearance to primary conidiophores but slightly narrower, they are 6-77 x 3-5 μm , often becoming geniculate. The lateral branches that develop from elongated secondary apical conidiophores produce the open, 3-dimensional pattern of sporulation that unifies members of the *A. infectoria* group.

Type (holotype): BPI 872336 (dried culture preparation ex RGR 04.0031, isol. Roberts from pedicel of *Pyrus bretschneideri*, local market, Wenatchee, Washington, U.S.A, 2004; original source likely Hebei Province, China.

Discussion

The type culture of *A. calycipyricola* was isolated from moribund floral remnants in the calyx of a European pear (*P. communis* 'd'Anjou') removed from commercial cold storage in Cashmere, WA in 1996. Noticed as a cottony growth on the calyx ends of several fruit, the mycelium appeared to be entirely superficial and was not associated with any type of lesion, discoloration, or other symptom. *A. calycipyricola* is provisionally represented by one additional isolate, RGR 96.0210, that does not produce protoascomata in culture and whose conidia are slightly larger. Isolates of *A. calycipyricola* and *A. avenicola* clustered together in the lowermost dendrogram branch in Fig. 4 (next page). *A. calycipyricola* differs from *A. avenicola*, with which it shares a superficial morphological resemblance, by virtue of its much smaller conidia, lack of ascospore production on agar media, lack of chlamydospore production and known host range.

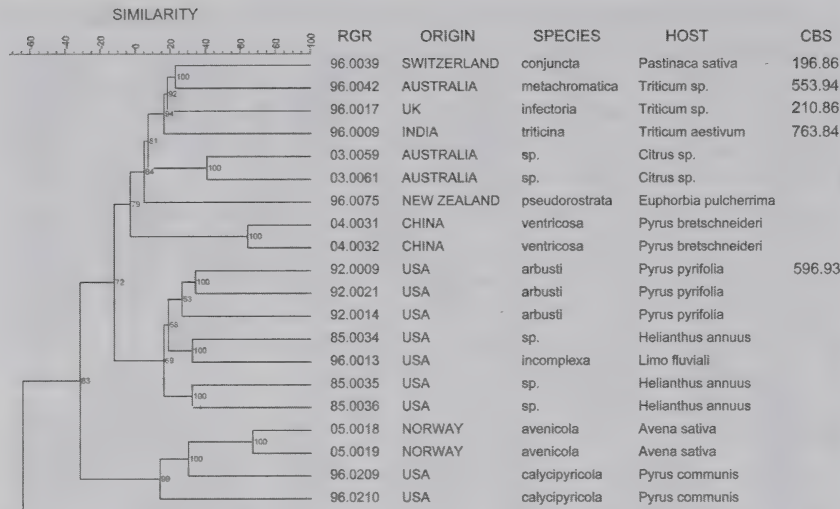


Fig. 4. Dendrogram branch from a combined cluster analysis of RAPD, RAMS and AFLP fingerprints of *Alternaria* strains belonging to the *A. infectoria* group sensu Simmons, extracted from a larger analysis of 164 isolates which represent all described sporulation pattern groups. Numbers at branch roots are cophenetic correlation values calculated for the entire dendrogram. The SIMILARITY scale is a relative measure based upon the whole-dendrogram similarity matrix, which was calculated from the combined similarity matrices for all experiments (fingerprint type) for each isolate. Corresponding Centraalbureau voor Schimmelcultures accession numbers are given for those isolates obtainable from that source.

The type culture of *A. ventricosa* was isolated from a symptomatic stem of a 'Ya Li' pear fruit (*P. bretschneideri* 'Ya Li') that had originated in Shandong or Hebei Provinces, China and was purchased from a retail market display in Wenatchee, WA. Both RGR 04.0031 and 04.0032 are notable because of the several hundred isolates studied from imported Ya Li pear fruit they are the only isolates that belong in the *A. infectoria* species group. Among the dozens of *Alternaria* isolations in the *infectoria* group studied to date, *A. ventricosa* is readily recognizable by the morphological characters of its mature erostrate conidia, and is clearly segregated from other *Alternaria* species in band-based cluster analyses. The status of *A. ventricosa* as a pathogen of *Pyrus* has not been confirmed in inoculation studies.

Acknowledgments

The constructive comments, encouragement and Latin diagnoses provided by EG Simmons over the years and for this paper are greatly appreciated. The thoughtful and thorough review of this manuscript by Birgitte Andersen is no less appreciated. Steve Reymond conducted the supporting molecular analyses, for which I am grateful.

Literature Cited

- Hantula J, Müller MM. 1997. Variation within *Gremmeniella abietina* in Finland and other countries as determined by Random Amplified Microsatellites (RAMS) Mycol. Res. 101:169-175.
- Kornerup A, Wanscher JH. 1989. Methuen Handbook of Colour, 3rd ed. Methuen: London (UK). 252 pp.
- Nishimura S, Sugihara M, Kohmoto K, Otani H. 1978. Two different phases in pathogenicity of the *Alternaria* pathogen causing black spot disease of Japanese pear. Journ. Fac. Agric., Tottori Univ. 13: 1-10.
- Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species-groups. Mycol. Res. 104:151-160.
- Roberts RG. 2005. *Alternaria yaliinficiens* sp. nov. on Ya Li pear fruit: From interception to identification. Plant Disease 89: 134-145.
- Saghai-Marooof MA, Soliman KM, Jorgensen RA, Allard RW. 1984. Fungal DNA isolation. PNAS 81: 8014-8018.
- Simmons EG. 1981. *Alternaria* themes and variations 1-2. Mycotaxon 13: 16-34.
- Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). Morphology and toxigenicity of *Alternaria* associated with black spot disease of Japanese pear. Mycotaxon 48: 109-140.

A new and noteworthy species of *Hygrophorus* from Yunnan, China

FU-QIANG YU^{1,2}, GUANG-BO XU³ & PEI-GUI LIU¹

fuqiangyu@gmail.com

¹Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany
Chinese Academy of Sciences, Kunming 650204, China

²Graduate University of Chinese Academy of Sciences
Beijing 100039, China

³Agricultural College of Yanbian University
Longjing 133400, China

Abstract—A new species, *Hygrophorus robustus*, is described and illustrated from Yunnan, China. It is characterized by a raw umber to pale ochre cap, ochre lamellae, and robust stipe. The relationship of the new species to other closely related species is discussed. The morphological characters of the shiro-like colony and carbonized blackish mycorrhiza are also presented, as well as their possible relationship to other related fungi.

Keywords—Agaricales, taxonomy, mushroom

Introduction

Hygrophorus species are common and conspicuous fungi around the world. They are renowned both for their often colorful sporocarps and regular occurrence in broadleaved, conifer or mixed forests of cool or warm temperate regions (Hesler & Smith 1963, Horak 1990, Candusso 1997, Yong 2005). Their macro- and micromorphological characters are quite diverse as well as their habitat conditions. Basidiocarps vary in size, with a few 8–15 cm in diameter; the hymenophore is waxy in texture; lamellae are typically thick but with sharp edges, usually distant to subdistant and characteristically with a clean appearance; stipes are confluent with the pileus and nearly always centrally attached; the gill trama is interwoven, subparallel to parallel, divergent or bilateral; basidiospores are rarely ornamented and are ellipsoidal to elongate or globose and white in deposit; basidia are typically long and narrow as

*Author for correspondence

in species of *Cantharellus* (Hesler & Smith 1963). However, knowledge about these mushrooms is still rather limited, and no studies specifically on the Chinese *Hygrophoraceae* have been published. Based upon the careful examination of four distinctive *Hygrophorus* collections (one from the field, three from local wild edible mushroom markets) from Yunnan, China, a new species, *H. robustus* is described and illustrated, including colony structure and mycorrhizal morphology.

Materials and methods

Macromorphological characters were taken from fresh specimens. Descriptions and illustrations of micromorphological characters were made using a Nikon E400 microscope with light and phase-contrast optics. Sections were made with a razor blade viewed under a stereomicroscope, mounted in 5% KOH, and Melzer's solution. Illustrations were made with a drawing tube. Specimens examined were deposited in the Cryptogamic Herbarium of Kunming Institute of Botany, Academia Sinica (HKAS).

Mycorrhizal samples were collected directly beneath sporocarps within a *Castanopsis delavayi* Franch. dominated forests in Zixi Mount. (Central Yunnan, China) in 2005. Colony samples, composed of mycelium, soil and roots which were traced back to the host tree, were placed in plastic bags, transported fresh to the laboratory and stored at 4°C. Mycorrhizal roots were cleaned of soil and debris in running tap water, and examined with a Nikon SMZ1500 stereomicroscope.

Taxonomy

Hygrophorus robustus F.Q. Yu, sp. nov.

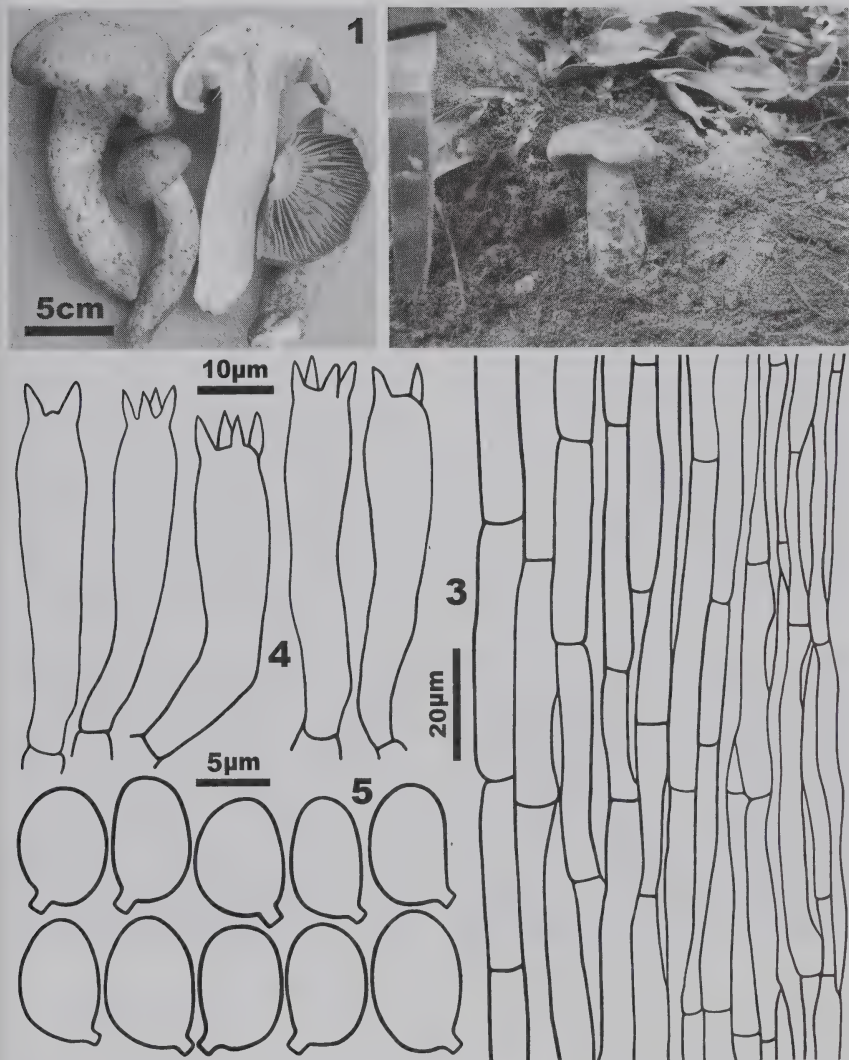
Fig. 1-5

MYCOBANK #MB510599

Pileus 60–120 mm *latus*, *subumbonatus* vel *convexus*, *marginem involuto dein recto*; *glaber*, *rudis* *umber* ut *stilus ochre*, *radiately-virga per appressed fibrillose*. *Lamellae cum adnate*, *sinuate vel arcuate*, *distantes*, *umber* ut *ochre*. *Stipes* 80–200 × 18–40 mm, *solidus*, *pervalidus*, *deorsum attenuato*, *annulum non obvisus*. *Carne alba*, *odor incommodus*. *Basidia clavata*, (40)52–60(63) × (8)10–13 μm; *basidiosporae* 8–10(10.5) × 5–6.5(7) μm, *obovate-elliptic*.

Etymology—The specific epithet refers to the robust sporocarps

Macromorphological features: *Pileus* 60–120 mm broad, hemispherical, convex to broadly convex; surface dry, more or less glabrous, radiately streaked by appressed fibrillose, raw umber to pale ochre, margin incurved (Fig.1, 2). Context thick, hard, white; taste mild. Odor pleasant, of freshly husked corn mixed with the aroma reminiscent of *Tricholoma matsutake* (S. Ito & S. Imai) Singer. Lamellae waxy, adnate, sinuate or arcuate, broad, distant, concolorous with pileus or even darker, with some lamellulae (Fig.1). Stipe 80–200 × 18–40 mm, very robust, somewhat like that of *Termitomyces eurhizus* (Berk.) R. Heim,



Figs 1-5: Macro- and micromorphological features of *Hygrophorus robustus*.

1. Sporocarps (HKAS 49785); 2. Sporocarp in natural habitat, showing *Tricholoma matsutake* appearance at young stage (HKAS 49786); 3. Section through Pileipellis (right side – pileus surface); 4. Basidia; 5. Basidiospores.

cylindrical, tapering at the base, longitudinally fibrillous-striate, splitting readily, grey white to dirty white, covered with concolorous appressed fibrous scale. Annulus not obvious, fibrillose, concolorous with the pileus, superior, subsistent. Context white, solid, compact (Fig.1).

Micromorphological features: Pileipellis a cutis of thin-walled hyphae, 4–9 μm wide, repent and extend in a periclinal direction, not sharply differentiated from the pileus trama, white yellow to yellowish brown; cells filamentous (Fig.3). Lamellar trama divergent or bilateral, hyphae mostly 3–6 μm in diameter, thin-walled, hyaline; cells filamentous. Subhymenium morphological undifferentiated. Basidia (40)52–60(63) $\times$ (8)10–13 μm , clavate to subcylindrical, hyaline, usually 4- or 2-spored, rarely 1-spored, sterigmata 6–10 μm long (Fig.4). Cystidia absent. Basidiospores 8–10(10.5) $\times$ 5–6.5(7) μm , 9 $\times$ 6 μm on average, $Q = (1.29)1.33\text{--}1.80(2.0)$, thin-walled, subellipsoid, occasionally ellipsoidal, hyaline, smooth, inamyloid (Fig.5). Stipitipellis a layer of repent hyphae, 4–8 μm in diameter, thin-walled, filamentous, hyaline.

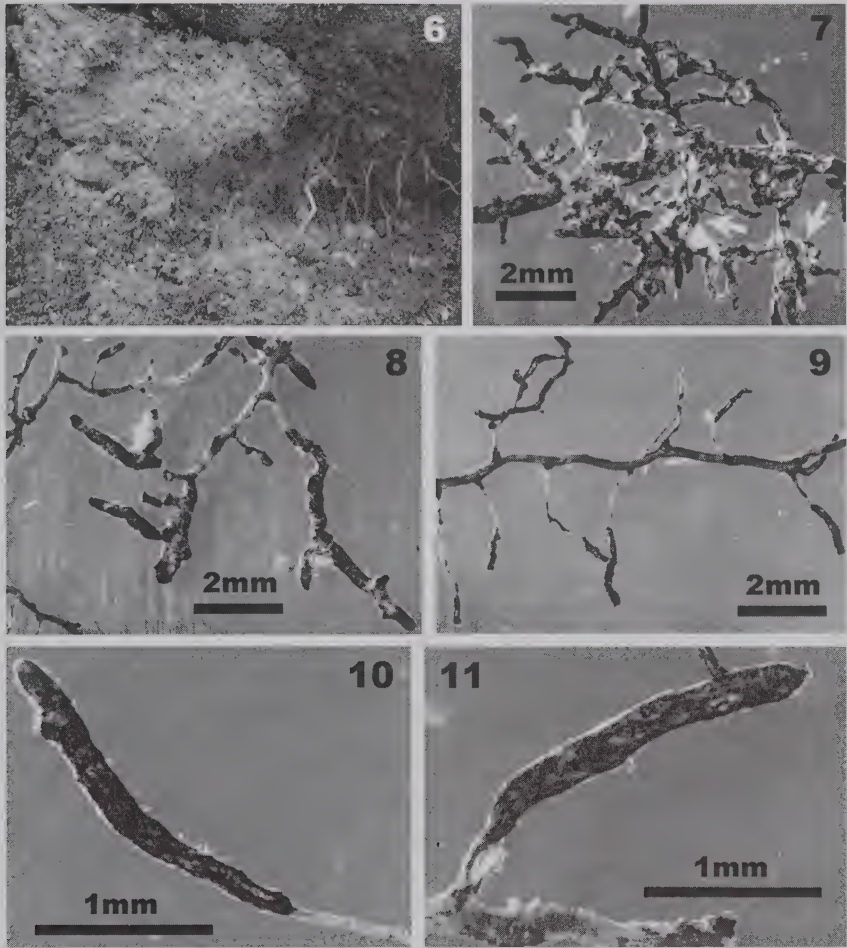
Habitats and ecology: *H. robustus* is associated with *C. delavayi* in Yunnan, China. Its exact distribution is still unknown but probably confined to subalpine regions of southwestern China. Fruiting in late July and early August.

Mycelial colony: *H. robustus* produces a dense white to pale gray mycelia mass beneath the sporocarp. This mycelium colonizes everything in the soil including plant roots, soil granules, rocks, and gaps between granules. The surface of the colony is immediately below the litter layer and in deep soil can be 10 cm from top to bottom. The diameter of the colony is about 15 cm (Fig.6).

Mycorrhizal morphology: Mycorrhizas 8–28 mm long, monopodial pinnate to irregular (Fig.7); tips 0.5–2.5 $\times$ 0.1–0.3 mm, mostly straight or bent, some slightly tortuous, yellowish brown to dark brown (Fig.8, 9), surrounded by tangled cottony hyphal masses which were difficult to separate and recognize as individual hyphae (Fig.7); surface of younger tips usually smooth, shiny, more or less clavate, plump, and yellowish brown in color (Fig.10); while the older tips are often coarse, wrinkled and pitted, easily broken, and progressively blacken and loose emanating elements (Fig.11).

Specimens examined—CHINA. YUNNAN PROVINCE: Yaoan Co. (E101°25', N25°04'), wild edible mushroom market, 4.VIII.1998, X. H. Wang 627 (HKAS 32908); Wuding Co. (E102°37', N25°25'), wild edible mushroom market, 12.VIII.1999, X. H. Wang 745 (HKAS 35825); Kunming City (E102°73', N25°05'), Wujing Road, wild edible mushroom market, 23.VII.2005, F. Q. Yu 1271 (HKAS 49785) (Holotype); Chuxiong City, Zixi Mount., Camellia Garden (E101°25'2", N24°59'96"), 27.VII.2005, alt. 2363 m, F. Q. Yu 1283 (HKAS 49786).

Notes—*Hygrophorus robustus* is a very peculiar species. It appears at first sight to belong to the *Tricholoma matsutake* group, especially in young stages (Fig.2). Specimens share a number of features including robust sporocarps, pale ochre colored pilei with radiately appressed fibrils, and a smell reminiscent of matsutakes, but the new species can be readily distinguished from *T. matsutake* sensu lato by its distant and waxy lamellae, long basidia, and divergent lamellar trama. *H. pudorinus* (Fr.) Fr. also possesses a robust stature, distinctly colored young pileus, and thick stipe, but differs in its buff to salmon colored pileus,



Figs 6-11: Colony and mycorrhiza of *Hygrophorus robustus*.

6. Shiro-like colony beneath the sporocarps, showing intermixed white mycelium, soil and mycorrhizas (HKAS 49786); 7. Mycorrhizal system on *Castanopsis delavayi*, showing monopodial pinnate to irregular ramification, adhering hydrophobic and cottony extraradical mycelium (arrows); 8. Straight and robust mycorrhizal tips; 9. Bent and delicate mycorrhizal tips; 10. Young mycorrhizal tip with yellow brown, smooth and plump surface; 11. Old mycorrhizal tip with dark brown, coarse and wrinkled surface.

pinkish-tinged lamella, stipe with a bright yellow base, and faintly fragrant odor (Hesler & Smith 1963).

H. robustus seldom appears at wild edible mushroom markets in Yunnan. It's often called "white matsutake", "rice water mushroom" and "false termite mushroom" by local people. One other *Hygrophorus* species commonly

encountered in Yunnan local markets is *H. russula* (Schaeff.) Kauffman. However, *H. russula* has close to crowded lamella that are white when young but which soon flush with pale pink and later develop purplish-red spots. In *H. russula*, pilei are usually smaller and pinkish-tinged while stipes are more slender and initially white, next stained, streaked, or laced with pink, and finally more or less concolorous with the pileus (Hesler & Smith 1963, Candusso 1997). The colony structure of *H. robustus* is fundamentally similar to the "Shiro" (Japanese for 'white castle' or 'fortress') found in the matsutake group [*Tricholoma bakamatsutake* Hongo (Terashima 1993), *T. caligatum* (Viv.) Ricken (Ohara & Ogawa 1982), *T. fulvocastaneum* Hongo (Ogawa 1977), *T. magnivelare* (Peck) Redhead (Ogawa 1979), *T. matsutake* (Yamada et al. 1999)]. Inside the shiro, everything is colonized (including plant roots, soil granules, rocks, and gaps between granules) and the soil appears white or pale grey, loose, and somewhat powdery and dry (Zhong 2004). The *H. robustus* colony, however, lacks the strong matsutake aroma.

Six mycorrhizal morphotypes formed by *Hygrophorus* spp. on *Larix* and *Picea* have been described. These morphotypes possess monopodial-pinnate mycorrhizas with long and straight or bent tips that are white, yellow to yellow brown with smooth or loosely cottony surfaces (Gronbach 1988, Treu 1990, Agerer 1991, Kranabetter & Friesen 2004). Externally, mycorrhizas of *H. robustus* associated with *C. delavayi* are blackish (carbonized) and have large amounts of adhesive hydrophobic extra-radical mycelia surrounding the mycorrhizas and in the soil. Other species that also possess carbonizing mycorrhizas include (in addition to *H. robustus* and members of the *T. matsutake* group) *Boletopsis leucomelaena* (Pers.) Fayod, *Hydnellum peckii* Banker, and *Phellodon niger* (Fr.) P. Karst (Ogawa 1977, 1979; Ohara & Ogawa 1982, Terashima 1993, Yamada et al. 1999), all species usually placed in the family *Thelephoraceae*. The morphological similarities of mycorrhizas among matsutake group species, thelephoraceous fungi and *H. robustus* suggest a physiological similarity of their associations.

Acknowledgements

The authors wish to thank Dr. Gregory M. Mueller of the Field Museum of Natural History and Dr. Sharon A. Cantrell of Universidad del Turabo for serving as reviewers and for their valuable comments and suggestions. This project was partially supported by the National Natural Science Foundation of China (30260071, 30470011).

Literature cited

- Agerer R. 1991. Characterization of ectomycorrhiza. In: Norris JR, Read DJ, Varma AK, eds. *Methods in microbiology*, vol. 23. Techniques for the study of mycorrhiza. Academic Press Ltd, London, 25-73.

- Candusso M. 1997. *Hygrophorus* s.l. Fungi Europaei 6. Liberia Basso, Alassio
- Gronbach E. 1988. Charakterisierung und Identifizierung von Ektomykorrhizen in einem Fichtenbestand mit Untersuchungen zur Merkmalsvariabilität in sauer beregneten Flächen. *Bibliotheca Mycologica* 125: 164-173.
- Hesler LR, Smith AH. 1963. North American species of *Hygrophorus*. The University of Tennessee Press, Knoxville
- Horak E. 1990. Monograph of the New Zealand *Hygrophoraceae* (Agaricales). *New Zealand Journal of Botany* 28: 255-309.
- Kranabetter M, Friesen J. 2004. Morphotype descriptions of common ectomycorrhizae fungi. http://www.for.gov.bc.ca/rni/research/Date_Creek/Mycorrhizae_Table/Mycorrhizae.htm#Morphotypes
- Ogawa M. 1977. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) Sing. and its allied species. VI. *Tricholoma fulvocastaneum* in *Quercus serrata*-*Quercus acutissima* forest. *Transactions of the Mycological Society of Japan* 18: 286-297.
- Ogawa M. 1979. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) Sing. and its allied species. IX. *Tricholoma ponderosum* in *Pseudotsuga menziesii*-*Tsuga heterophylla* and *Pinus contorta* forests. *Transactions of the Mycological Society of Japan* 20: 370-382.
- Ohara A, Ogawa M. 1982. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) and its allied species. XI. *Tricholoma caligatum* in *Cedrus libanotica* forests. *Transactions of the Mycological Society of Japan* 23: 365-377.
- Terashima Y. 1993. Distribution and external morphology of mycorrhizal roots at shiros of *Tricholoma bakamatsutake* in a mixed forest of *Pasania edulis* and *Castanopsis cuspidate* var. *sieboldii*. *Transactions of the Mycological Society of Japan* 34: 495-505.
- Treu R. 1990. Charakterisierung und Identifizierung von Ektomykorrhizen aus dem Nationalpark Berchtesgaden. *Bibliotheca mycologica* 134: 21-24.
- Yamada A, Kanekawa S, Ohmasa M. 1999. Ectomycorrhiza formation of *Tricholoma matsutake* on *Pinus densiflora*. *Mycoscience* 40: 193-198.
- Young AM. 2005. Fungi of Australia *Hygrophoraceae*. Australian Botanical resources, study and CSIRO Publishing, Victoria
- Zhong SC. 2004. The North American matsutake. In: *Proceedings of the Forum on Development of Matsutake Industry, Shangri-la*, 17-24.

New morphological data on *Amauroderma brasiliense* (*Polyporales, Basidiomycota*)

GILBERTO COELHO, VAGNER G. CORTEZ & ROSA T. GUERRERO

coelhogb@yahoo.com.br

Universidade Federal do Rio Grande do Sul,

Programa de Pós-graduação em Botânica

Av. Bento Gonçalves, 9500, CEP: 91501-970 Porto Alegre, RS, BRAZIL

Abstract—Fresh basidiomes of the basidiomycete *Amauroderma brasiliense* were studied allowing the observation of new morphological structures for the species, i.e., gloeopleurous hyphae in the context and trama and dendrohyphidia. Scanning electron microphotograph showing the basidiospores ornamentation is provided for the first time.

Key words—Neotropical fungi, Brazilian mycobiota, polypore, *Ganodermataceae*

Introduction

The genus *Amauroderma* Murrill (*Ganodermataceae, Basidiomycota*) is characterized by its double-walled ganodermatoid spores with a smooth to ornamented exosporium and a columnar endosporium; basidiomes are usually colored in shades of brown, stipitate, and tough to woody in consistency (Furtado 1981, Ryvarden 2004). The genus comprises around 20 widespread tropical species (Kirk et al. 2001).

Amauroderma corneri was described from São Paulo State, Brazil (Gulaid & Ryvarden 1998); and was later recorded from the states of Paraná, Rio Grande do Sul (Ryvarden & de Meijer 2002) and Santa Catarina (Groposo & Loguercio-Leite 2005), besides other countries such as Guyana (Aime et al. 2003) and Venezuela (Ryvarden & Iturriaga 2004). Recently, Ryvarden (2004) transferred *Scutiger brasiliensis* – described by Singer et al. (1983) based on collections from Amazonas and Santa Catarina States – to *Amauroderma* recognizing *A. corneri* as a latter synonym of the former, as well. As stated by Ryvarden & de Meijer (2002), the species has been overlooked and rarely collected in Brazil but it seems to be widespread in the country and, more likely, throughout the Neotropics.

Our study of fresh collections contributes a better understanding of the morphology of one species by revealing structures susceptible to desiccation that are difficult to observe in dried specimens.

Materials and methods

Fresh basidiomes of *A. brasiliense* were collected at the municipality of Itaara, in the central region of the southernmost Brazilian state, Rio Grande do Sul. Typical vegetation includes subtropical seasonal forests with some deciduous tree species that originated in the Parana/Uruguay Basins and sparse remnants of relict *Araucaria* rain forests dominated by *Araucaria angustifolia* (Bertol.) Kuntze, a canopy emergent tree (Rambo 1956). The understory encompasses several tropical and subtropical species that develop under partial shade and wet throughout the year, except for winter period when canopy defoliation increases light exposure.

Macro- and microscopical analyses of the basidiomes followed the usual methodology for the study of polypores (Núñez & Ryvarden 2000). Color codes are those of Munsell (1994). Abbreviations are as follows: D_m = mean diameter of the hyphae; $L_m \times W_m$ = mean length and mean width (from which Q is calculated, L_m/W_m); $n = x/y$: x number of measurements from y number of specimens; P = number of pores per centimeter; Q_r = range of Q ; Q_m = mean of Q . Collected specimens are deposited at the ICN herbarium (Holmgren & Holmgren 1998). For scanning electron microscopy (SEM), dried herbarium material was mounted directly on aluminium stubs and coated with a 5 nm thick layer of gold using a Balzers SCD 050 Sputter. Stubs were examined in a Jeol JSM 5800 scanning electron microscope operating with an accelerating voltage of 20 kV.

Taxonomy

Amauroderma brasiliense (Singer) Ryvarden, Synopsis Fung. 19: 44, 2004,
as *A. 'brasiliensis'*.

FIGS. 1-6

= *Scutigera brasiliensis* Singer, Nova Hedwigia, Beih. 77: 22, 1983.

= *Amauroderma corneri* Gulaid & Ryvarden, Mycol. Helv. 10: 28, 1998.

Basidiome annual, laterally stipitate. Pileus rounded to almost flabelliform, depressed, up to about 95 × 80 × 16 mm, cartilaginous, flexible and somewhat humid when fresh, firm and light in weight when dried; pileus surface without cuticle, dull, tomentose to hirsute in some parts, light yellowish brown (6/4 10YR), brownish yellow (6/6 10YR) to yellowish brown (5/4–5/8 10YR), slightly striate near to the margin; margin rather incurved, sometimes folded, very pale yellow (7/3–7/4 10YR), smooth, wavy to fimbriate. Stipe yellowish brown (5/4–5/8 10 YR) to dark yellowish brown (4/4–4/6 10YR), eccentric to

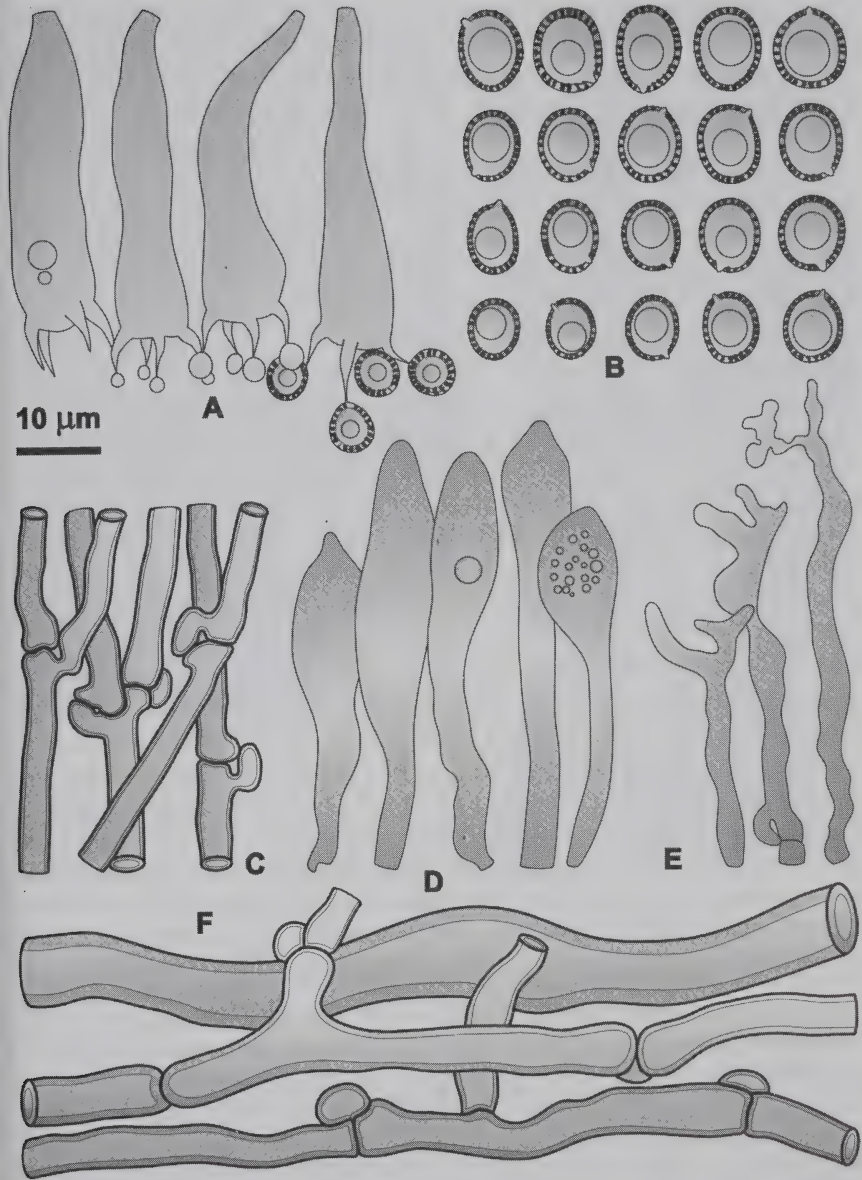


Fig. 1. *Amauroderma brasiliense*.

A. Basidia. B. Basidiospores. C. Generative hyphae from trama. D. Gloeocystidia.
E. Dendrohyphidia. F. Generative hyphae from context.

lateral, more tomentose than the pileus, 34×15 mm, expanded towards the pileus. Hymenophore poroid to hydroid, very pale brown (8/2–7/4 10YR) lighter than the pileus surface, extending up to a sterile marginal zone which contours the incurved margin with about 2 mm in width; pores sinuous to daedaloid at the hymenophore center, becoming intensely lacerate towards the margin, sometimes reduced to teeth or spines, $(2-)\text{3--7}(-9)/\text{cm}$, $P = 5.27/\text{cm}$, $n = 45/2$, usually larger; dissepiments entire to lacerate. Context conspicuous, up to 3 mm, homogeneous, white (8/1 10YR) to very pale brown (8/2–8/4 10YR), contrasting with the pileus surface, soft, almost fresh when dried, becoming hard when dried. Tube layer concolorous with the context, up to 12 mm thick, similar to the context, inseparable, soft, flexible.

Hyphal system monomitic to possibly dimitic with long and thick-walled contextual hyphae sometimes resembling skeletal hyphae, but with a basal clamp. Tramal generative hyphae clamped, thin- to slightly thick-walled, but rarely thick-walled, $(1.6-)\text{2--4.4}(-5.2)$ μm in diam., $D_m = 3.2$, $n = 155/3$. Contextual generative hyphae $(2.8-)\text{3.6--9.2}(-11.2)$ μm in diam., $D_m = 6.3$, $n = 85/2$, usually thick-walled and branched, with evident clamp connections. Gloeopleurous hyphae found in the context and trama, intensely staining in phloxine, content homogeneous, long, tortuous, variable in thick, branched, $(2-)\text{3.2--6.8}(-8.4)$ μm in diam. in trama, $D_m = 4.6$, $n = 48/1$; $(3.2-)\text{4.4--17.6}(-20.8)$ μm in diam. in context, $D_m = 8.7$, $n = 60/1$.

Hymenium with basidia clavate, sometimes centrally constricted, $(6.4-)\text{24--60}(-96) \times (6.4-)\text{6.8--10}(-13.6)$ μm , $L_m \times W_m = 40.9 \times 8.62$; $Q_r = 1.56\text{--}11.43$, $Q_m = 4.88$; $n = 90/3$, tetrasporic. Spores $(5.6-)\text{6--9.2}(-10) \times (4.4-)\text{5.2--7.2}(-8)$ μm ($L_m \times W_m = 7.5 \times 6.24$; $Q_r = 1.03\text{--}1.62$, $Q_m = 1.19$; $n = 136/2$), subglobose to broadly-ellipsoid, hyaline, with exosporium being almost smooth under light microscopy, but verrucose under SEM. Gloecystidia clavate to almost capitate with intensely staining content in phloxine, $(28-)\text{36.6--64}(\text{68.8}) \times (4.4-)\text{7.2--10}(-14.4)$ μm , $L_m \times W_m = 44.5 \times 8.74$; $Q = 2.56\text{--}8.91$, $Q_m = 5.23$; $n = 40/2$, they were easily confounded with basidioles when weakly stained in phloxine.

Substrate: on decayed angiosperm wood, in subtropical forest.

Studied material: BRAZIL. Rio Grande do Sul State: Itaara, Parque Pinhal, leg. V.G. Cortez & G. Coelho, 19.V.2000, G. Coelho 227–10 (ICN 139055); *ibid*, 22.V.2001, G. Coelho 300–1, (ICN 139056); *ibid*, 17.III.2002, G. Coelho, G. Coelho 342–4 (ICN 139057).

Remarks: The studied basidiomes of *Amauroderma brasiliense* were fragile when fresh but tough when dried and possessed an elongate, tapering stipe. The hymenial surface is composed of variably large pores $(2-)\text{3--7}(-9)/\text{cm}$. The hyphal system is monomitic to possibly dimitic with the generative hyphae predominating. The subglobose to broadly ellipsoid spores measure $5.5\text{--}10 \times 4.5\text{--}8$ μm .

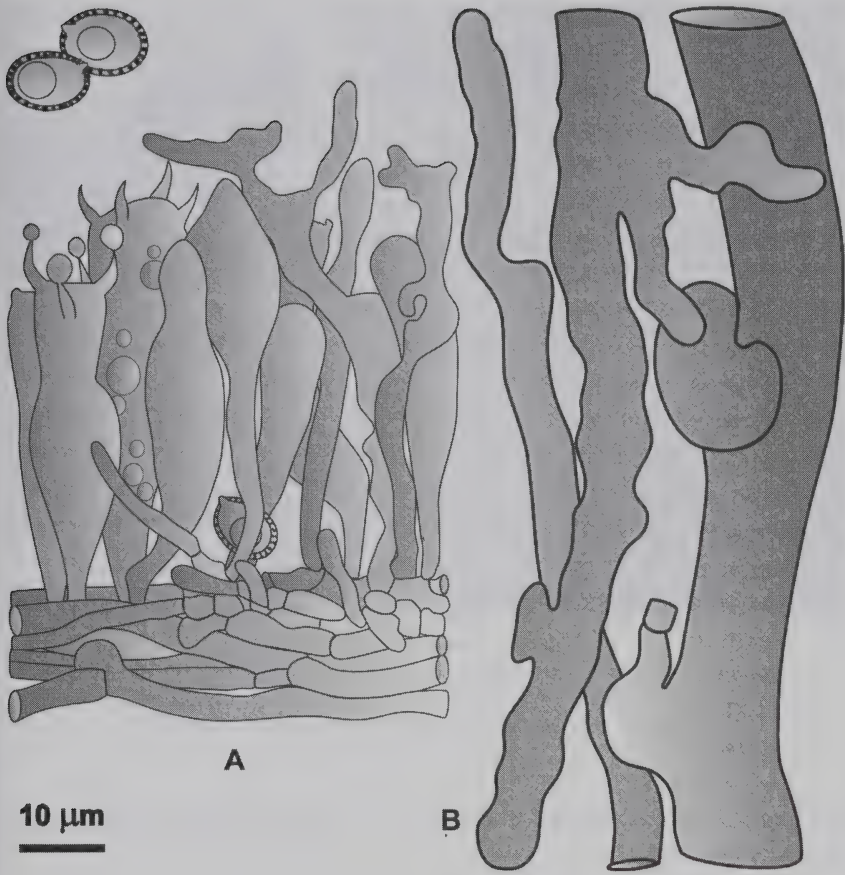
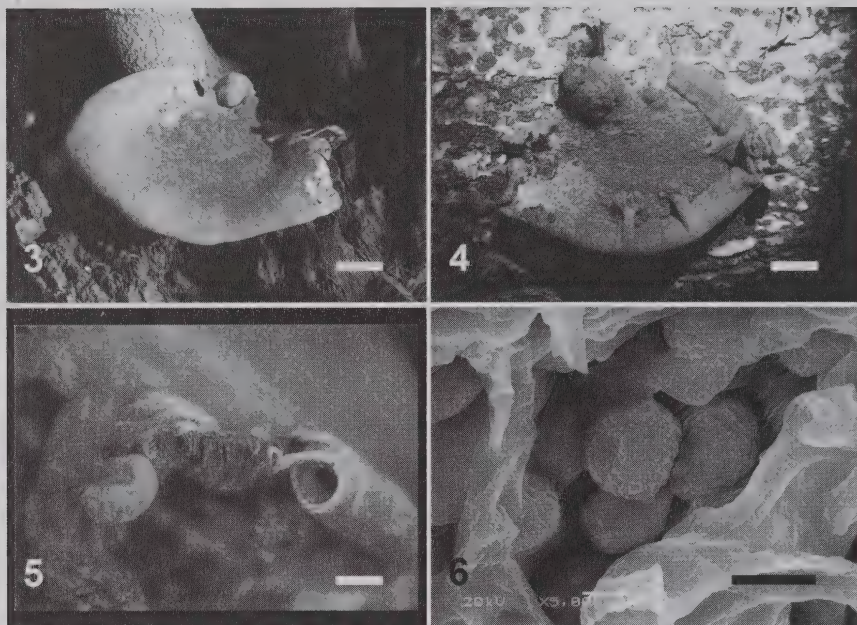


Fig. 2. *Amauroderma brasiliense*.

A. Detail of hymenium. B. Gloeopleurous hyphae from trama and context.

Structures observed in fresh basidiomes not previously reported for the species include dendrohyphidia and the presence of gloeopleurous hyphae in the context and trama. Hymenial gloeocystidia were also observed; these had not been mentioned in recent species descriptions (Gulaid & Ryvarden 1998) but had been clearly described by Singer et al. (1983) as ampullaceous cystidia, $33\text{--}53 \times 10\text{--}11.3\text{ }\mu\text{m}$. The finely asperulate basidiospore ornamentation seen in optical microscopy, a common character within the genus, is shown to be verrucose to almost rugose in SEM studies.

It must be noted that correct spelling of the species name is *A. brasiliense*, not *A. brasiliensis*, as originally given in Ryvarden (2004). The name derives from the Latinized “*Brasilia*” and not the Portuguese “*Brasil*”; furthermore, the neuter



Figs. 3-6. *Amauroderma brasiliense*.

3-4. Upper (3) and lower (4) views of pileus on angiosperm decayed wood. Scale bar = 1 cm.

5. Side view of pileus near the lateral stipe showing context and tube layer. Scale bar = 0.5 cm.

6. SEM of the basidiospores. Scale bar = 8 μ m (5000 x, 20 kV).

termination *-ense* is required so that the species epithet agrees with the neuter genus, *Amauroderma*.

Acknowledgements

The authors are grateful to Center of Electron Microscopy (Universidade Federal do Rio Grande do Sul) for making possible the SEM studies. M.Sc. Josué Michels is thanked for providing useful literature. Jean Carlos Budke is acknowledged for the improvement on description of ecological forest data. Special thanks to Dr. Leif Ryvarden (University of Oslo, Norway) and Dr. Clarice Loguercio-Leite (Universidade Federal de Santa Catarina, Brazil) for the invaluable criticism of the manuscript and Dr. Shaun Pennycook (Mycotaxon) for nomenclatural advice.

Literature cited

- Aime MC, Henkel TW, Ryvarden L. 2003. Studies in Neotropical polypores 15: new and interesting species from Guyana. *Mycologia* 95: 614-619.
- Furtado JS. 1981. Taxonomy of *Amauroderma* (Basidiomycetes, Polyporaceae). *Memoirs of the New York Botanical Garden* 34: 1-109.

- Groposo C, Loguercio-Leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. *Mycotaxon* 92: 103-106.
- Gulaid H, Ryvarden L. 1998 Two new species of *Amauroderma* (*Ganodermataceae*, *Basidiomycetes*). *Mycologia Helvetica* 10: 25-30.
- Holmgren PK, Holmgren NH. 1998. Index Herbariorum. New York Botanical Garden. Available at: <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. Wallingford (UK): CABI.
- Munsell. 1994. Munsell Soil Color Charts. Macbeth (USA): Munsell Co.
- Núñez M, Ryvarden L. 2003. East Asian Polypores. Oslo (Norway): Fungiflora.
- Rambo B. 1956. A Fisionomia do Rio Grande do Sul. 3 ed. São Leopoldo (Brazil): Ed. Unisinos.
- Ryvarden L. 2004. Neotropical Polypores. Vol. 1. Oslo (Norway): Fungiflora.
- Ryvarden L, de Meijer AAR. 2002. Studies in Neotropical polypores 14: new species from the State of Paraná, Brazil. *Synopsis Fungorum* 15: 34-69.
- Ryvarden L, Iturriaga T. 2004. Studies in Neotropical polypores 21: new and interesting species from Venezuela. *Synopsis Fungorum* 18: 68-75.
- Singer R, Araujo I, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially central Amazonia. *Nova Hedwigia*, Beih. 77: 1-352.

Aphyllphoraceous wood-inhabiting fungi on *Abies alba* in Italy

ANNAROSA BERNICCHIA¹, ELENA SAVINO² & SERGIO PÉREZ GORJÓN³

¹annarosa.bernicchia@unibo.it ²esavino@et.unipv.it ³spgorjon@usal.es

¹Dipartimento di Scienze e Tecnologie Agroambientali
Patologia Vegetale Università degli Studi di Bologna
Via Fanin 42, 40127 Bologna Italy

²Dipartimento di Ecologia del Territorio (DET), Università di Pavia
Via S. Epifanio 14, 27100 Pavia Italy

³Departamento de Botánica & Centro Hispano-Luso de Investigaciones Agrarias
Universidad de Salamanca
Ldo. Méndez Nieto s/n, 37007 Salamanca Spain

Abstract — 190 species representing 101 genera of aphyllphoraceous fungi growing on *Abies alba* in Italy are listed. *Ceriporia aurantiocarnescens* is reported as new to Italy. *Fomitopsis labyrinthica* has previously been described as a new species from this substrate, while many species identified are considered rare in Italy. The complete annotated specimen list is available on

<http://www.mycotaxon.com/resources/weblist.html>.

Key words — lignicolous fungi, diversity, coniferous forests

Introduction

In parallel with previous reports on Italian lignicolous fungi (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006), we have compiled a list of aphyllphoraceous fungi growing on Silver Fir (*Abies alba* Mill.) in Italy. The full area covered (Figure 1) extends from the montane forests of Central Europe from the Pyrenees and adjacent mountains in northern Spain, east and south through the Italian Alps and Apennines, and east into Macedonia and the lowland forests of western France and eastern Poland (see also Chater 1964).

The two *Abies* species in Italy are *A. nebrodensis*, restricted to the Madonie Mountains of Sicily, and *A. alba*, extending from the Alps and Apennines to the north to Aspromonte in the south. *A. alba* has suffered a recent decline due to natural and/or anthropogenic causes (Bernetti 1998). Italy has a typically



Figure 1. Approximate distribution of *Abies alba* in Europe

Mediterranean climate except for the Continental and highest zones in the interior with lower temperatures where coniferous forests of *Abies*, *Larix*, *Picea* and *Pinus* are common. *A. alba* is about as resistant to low winter temperatures as *Picea* and its other climatic requirements generally resemble those of *Fagus sylvatica* and *Picea abies*, but *A. alba* requires higher summer temperatures to ripen the seeds, is more tolerant to spring frosts, and avoids areas with high humidity.

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *A. alba* is present: Basilicata, Calabria, Emilia-Romagna, Friuli Venezia Giulia, Piemonte, Toscana, Trentino-Alto Adige, Valle d'Aosta and Veneto. Samples were taken to the laboratory for microscopical examination and identification following Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All the specimens are kept in Herbarium HUBO. The list is partially referred to Bernicchia (1995, 2001), Onofri (2005) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007). A list and map of the 26 collection localities are included in the annotated specimen list posted on <http://www.mycotaxon.com/resources/weblist.html>.

Results

Our survey of 536 specimens collected on *Abies alba* represents 190 species and 101 different genera of aphyllphoraceous wood-inhabiting fungi. Of these, *Ceriporia aurantiocarnescens* (Henning) M. Pieri & B. Rivoire is new to Italy. Especially rare or uncommon species include *Amphinema diadema* K.H. Larss. & Hjortstam, *Antrodia alpina* (Litsch.) Gilb. & Ryvarden, *Antrodiella parasitica* Vampola, *Flavophlebia sulfureoisabellina* (Litsch.) K.H. Larss. & Hjortstam, *Coronicium gemmiferum* (Bourdote & Galzin) J. Erikss. & Ryvarden, *Cystostereum murrayi* (Berk. & M.A. Curtis) Pouzar, *Dentipellis fragilis* (Pers.) Donk, *Fomitopsis labyrinthica* Bernicchia & Ryvarden, *Galzinia incrustans* (Höhn. & Litsch.) Parmasto, *Lobulicium occultum* K.H. Larss. & Hjortstam, *Metulodontia nivea* (P. Karst.) Parmasto, *Oligoporus cerifluus* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *O. lowei* (Pilát ex Pilát) Gilb. & Ryvarden, *O. simani* (Pilát) Bernicchia, *Paulliticortium pearsonii* (Bourdote) J. Erikss., *Phlebia georgica* Parmasto, *P. queletii* (Bourdote & Galzin) M.P. Christ., *Pycnoporellus fulgens* (Fr.) Donk, *Repetobasidium mirificum* J. Erikss. and *Tylospora asterophora* (Bonord.) Donk.

While many of these species can grow on other substrata, some of them typically fruit on *Abies*, such as *Bondarzewia montana* (Quél.) Singer, *Ganoderma carnosum* Pat., *Hymenochaete cruenta* (Pers.) Donk, *Phellinus hartigii* (Allesch. & Schnabl) Pat., and *Podofomes trogii* (Fr.) Pouzar. Species typical of deciduous substrata found also growing on *Abies* include *Abortiporus biennis* (Bull.) Singer, *Hapalopilus nidulans* (Fr.) P. Karst., *Inonotus dryadeus* (Pers.) Murrill, *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvarden, *Polyporus badius* (Pers.) Schwein., *Trametes hirsuta* (Wulfen) Pilát, and *Trametes pubescens* (Schumach.) Pilát.

Conclusions

The numbers of wood-inhabiting fungi (190) identified from *Abies alba* substrata in Italy are higher than those from other substrata researched thus far: 126 species on *Castanea sativa* (Mayrhofer et al. 2001), 105 species on *Juniperus* spp. (Bernicchia 2000) and 52 species on *Arbutus unedo* (Pérez Gorjón et al. 2006). This could be partly due to the greater abundance of Silver Fir forests compared with forests of the other species mentioned. Some areas (such as the Reserve of "Sasso Fratino") that harbour a high number of rare fungal species are potential candidates for biodiversity conservation.

Acknowledgements

We would like to thank Dr. Silvano Onofri (Italy) and Dr. Leif Ryvarden (Norway) for critically reviewing the manuscript. The third author is supported by a research grant co-financed by the European Social Fund and the Junta de Castilla y León (Spain).

Literature cited

- Bernicchia A. 1995. *Aphyllphorales* della Riserva Naturale Integrale di Sasso Fratino (Forlì), Italia. Primo contributo. Gior. Bot. It. 129: 837-857.
- Bernicchia A. 2000. Wood-inhabiting aphyllphoraceous fungi on *Juniperus* spp. in Italy. Mycotaxon 75: 241-256.
- Bernicchia A. 2001. A checklist of Corticioid, Polyporoid and Clavarioid fungi (*Basidiomycetes*) from the Emilia-Romagna region, Italy. Sydowia 53(1): 1-33.
- Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei, 10. Ed. Candusso. Alassio. Italy.
- Bernetti G. 1998. Selvicoltura speciale. UTET Torino. Italy.
- Burdsall HH. 1985. A Contribution to the Taxonomy of the Genus *Phanerochaete* (*Corticaceae*, *Aphyllphorales*). Mycol. Mem. No. 10, Cramer, Germany.
- CBS. 2007. Aphyllphorales database. www.cbs.knaw.nl/databases/index.htm.
- Chater AO. 1964. *Abies* Miller, in Flora Europaea. Vol 1: 29-30. Cambridge: Cambridge University Press.
- Donk MA. 1984. Check list of European polypores. North. Holland Publ. Comp. Amsterdam. The Netherlands.
- Eriksson J, Ryvarden L. 1973-1975-1976. The *Corticaceae* of North Europe. Vols. 2-3-4. Fungiflora, Oslo, Norway.
- Eriksson J, Hjortstam K, Ryvarden L. 1978-1981-1984. The *Corticaceae* of North Europe. Vols. 5-6-7. Fungiflora, Oslo, Norway.
- Hjortstam K. 1998. A checklist to genera and species of corticioid fungi (*Basidiomycotina*, *Aphyllphorales*). Windahlia 23: 1-54.
- Hjortstam K, Larsson KH, Ryvarden L. 1988. The *Corticaceae* of North Europe. Vol. 8. Fungiflora, Oslo, Norway.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th edition. CABI Publishing, Oxon, U.K.
- Köljalg U. 1995. *Tomentella* (*Basidiomycota*) and related genera in Temperate Eurasia. Synopsis fungorum 9: 1-213.
- Mayrhofer S, Peintner U, Bernicchia A. 2001. Wood-inhabiting aphyllphoraceous fungi on *Castanea sativa* in Italy. Mycotaxon 80: 267-280.
- Onofri S. (coord.). 2005. Checklist of Italian fungi. Carlo Delfino editore.
- Parmasto E. 1997. CORTBASE – a nomenclatural taxa base of corticioid fungi (*Hymenomycetes*). Mycotaxon 61: 467-471.
- Pérez Gorjón S, Bernicchia A, Baptista Gibertoni T. 2006. Aphyllphoraceous wood-inhabiting fungi on *Arbutus unedo* in Italy. Mycotaxon 98: 159-162.
- Ryvarden L, Gilbertson, RL. 1993-1994. European Polypores. Vols. 1-2. Fungiflora, Oslo, Norway.

A new species of *Phaeoramularia* on *Ranunculaceae*FENG-YAN ZHAI¹ YING-LAN GUO² YU LI^{1*}¹fengyan780103@163.com ^{1*}yuli966@126.com

Jilin Agricultural University

Changchun 130118, China

²guoyl@sun.im.ac.cn

Institute of Microbiology, Chinese Academy of Science

Beijing 100101, China

Abstract—A new species, *Phaeoramularia delphinii* on *Delphinium* sp. of *Ranunculaceae* is reported. Latin diagnosis, illustration and English description of the new species are provided. Distinctions between the new taxon and its closely related species: *P. clematidis*, *P. lomaensis*, and *P. sudanensis* are discussed. The type and isotype specimens are deposited in HMAS and HMJAU.

Key words—imperfect fungi, taxonomy

Introduction

Recently we found a fungus on *Delphinium* specimens collected from Inner Mongolia. Its multiseptate, ellipsoid to cylindrical, catenate conidia produced in chains on fasciculate conidiophores that emerged through stomata from substomatal stomata, and other characters, indicated that it belonged in the genus *Phaeoramularia*. We compared it with all the other *Phaeoramularia* species reported on *Ranunculaceae*, and found it was distinctly different from them. So we identified it a new *Phaeoramularia* species and describe it here.

Taxonomy

Phaeoramularia delphinii F.Y. Zhai, Y.L. Guo & Yu Li, sp. nov.

Fig. 1

MYCOBANK MB510634

Maculae amphigenae, ellipsoideae, subellipsoideae vel irregulares, 3.0–10.0 mm diam., primo griseo-aterae irregulatin discoloratae, demum centro olivaceae vel luteo-brunneae, margine atro-brunneae, extus haloratis pallide luteo-brunneis vel atro-brunneis. Caespituli amphigeni. Mycelium immersum. Stromata substomata, bene evoluta, subglobosa, luteo-brunnea, 18.0–79.0 µm diam. Conidiophora emergena per stomata, laxe vel dense

*Corresponding author

fasciculata, olivacea vel moderate olivaceo-brunnea, laevia, non ramosa, erecta vel leviter curvata, 1–4-geniculata, ad apicem conico-truncata, 0–1-septata, $26.0\text{--}69.0 \times 2.5\text{--}5.0\ \mu\text{m}$. Cicatrices conspicue, incrassatae, $1.0\text{--}2.5\ \mu\text{m}$ latae. Conidia ellipsoidea vel cylindrica, olivacea vel moderate olivaceo-brunnea, catenata, laevia, erecta, ad apicem conico-truncata, ad basin obconico-truncata, 0–3-septata, imprimis 0–1-septata, interdum constricta, $12.0\text{--}37.0 \times 3.5\text{--}8.0\ \mu\text{m}$.

Leaf spots amphigenous, elliptical, subelliptical or irregular, 3.0–10.0 mm diam., at first in irregularly grayish black discolored patches, later center olivaceous to yellowish brown, margin dark brown, with a pale yellowish brown to dark brown halo on the upper surface, paler on the lower surface. Fruiting amphigenous. Mycelium immersed. Stromata substomatal, well-developed, subglobose, yellowish brown, $18.0\text{--}79.0\ \mu\text{m}$ diam. Conidiophores emerging through stomata, loosely to densely fasciculate (up to about 80 in a large fascicle), olivaceous to moderate olivaceous brown, olivaceous brown when in cluster, paler towards the apex, smooth, not branched, straight to slightly curved, 1–4-geniculate, regular or irregular in width, conically truncate at the apex, 0–1-septate, $26.0\text{--}69.0 \times 2.5\text{--}5.0\ \mu\text{m}$. Conidial scars conspicuously thickened, $1.0\text{--}2.5\ \mu\text{m}$ wide. Conidia ellipsoid to cylindrical, olivaceous to moderate olivaceous brown, catenate and often in branched chains, smooth, straight, conically truncate at the apex, obconically truncate at the base, 0–3-septate, mostly 0–1-septate, sometimes constricted, $12.0\text{--}37.0 \times 3.5\text{--}8.0\ \mu\text{m}$.

On leaves of *Delphinium* sp. (*Ranunculaceae*), Arxan, Inner Mongolia, 9 VIII 1991, coll. Y. L. Guo, no. 1533 (HMAS 143918, holotype; HMJAU 30003, isotype); no. 1667 (HMAS 143919).

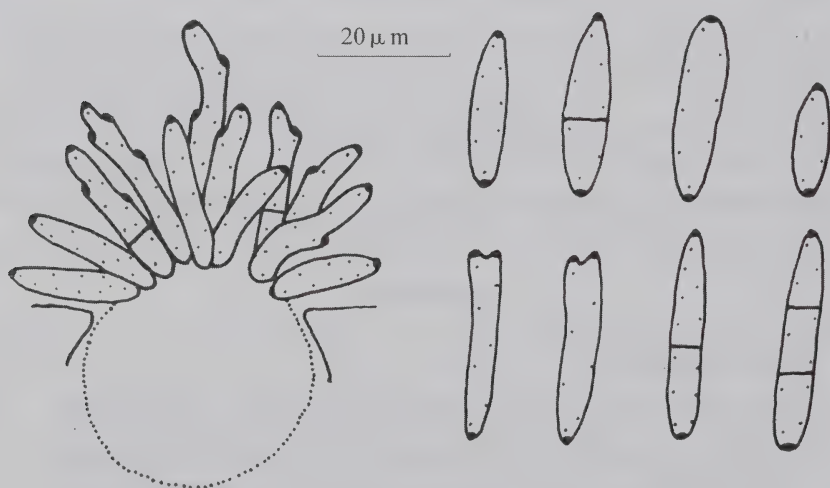


Fig. 1 *Phaeoramularia delphinii*
Conidiophores and conidia (HMAS 143918)

Table 1 Comparisons among four related *Phaeoramularia* species

Species		<i>P. delphinii</i>	<i>P. clematidis</i>	<i>P. lomaensis</i>	<i>P. sudanensis</i>
Items					
Leaf spots		+	+	–	–
Fruiting		amphigenous	hypogenous	hypogenous	hypogenous
	fascicle	~ 80	5–8	~ 12	~ 12
	color	olivaceous to moderate olivaceous brown	pale olivaceous brown to pale brown	moderate olivaceous	moderate olivaceous
Conidiophores					
	length	26.0–69.0	20.0–48.5	≤ 200.0	≤ 175.0
	width	2.5–5.0	2.0–4.0	4.0–6.0	4.0–5.0
Conidial scars					
	length	1.0–2.5	1.0	1.5	1.5–2.0
	color	olivaceous to moderate olivaceous brown	subhyaline to very pale brown	moderate olivaceous	pale olivaceous
Conidia					
	septa	0–3 (mostly 0–1)	1–2	0–5 (mostly 1–3)	1–5
	length	12.0–37.0	14.0–38.0	17.0–74.0	16.0–78.0
	width	3.5–8.0	2.5–5.0	4.0–6.5	4.0–6.5

Comments: Crous & Braun (2003) reduced *Phaeoramularia* to synonymy with *Passalora*, which mainly differs from *Phaeoramularia* by forming solitary conidia. Crous & Braun claimed that amongst cercosporoid hyphomycetes the formation of single or catenate conidia was not tenable as a distinguishing character at generic rank, noting that this was supported by results from ITS and 5.8S rDNA sequence analysis (Crous et al. 2001). However, we wish to emphasize morphological characteristics and believe that the mode of conidia formation, singly or in chains, is a major characteristic delimiting cercosporoid hyphomycetes, including *Phaeoramularia* and *Passalora*. We therefore maintain *Phaeoramularia* as a separate genus in this paper.

Three other *Phaeoramularia* species also occur on *Ranunculaceae*: *P. clematidis* S. K. Singh & R. K. Chaudhary (Singh et al. 1995), *P. lomaensis* Deighton (Deighton 1979), and *P. sudanensis* Deighton (Deighton 1979). All three species, however, are associated with *Clematis*, not *Delphinium*.

Phaeoramularia clematidis (found on *Clematis gouriana* Roxb.) exhibits hypogenous fruiting, bears 5–8 conidiophores in a fascicle that are darker, shorter and narrower and bear smaller conidial scars, and produces conidia that are mostly solitary, occasionally catenate, or (more rarely) branched, subcylindrical, paler, 1–2-septate, and narrower.

P. lomaensis and *P. sudanensis* (also on *Clematis* spp.) do not form leaf spots, exhibit hypogenous fruiting, bear ~12 conidiophores per fascicle that are paler, usually branched, rarely simple, sinuous or geniculate, and longer, and produce conidia that are paler, more septate, longer, and narrower. In addition *P. sudanensis* lacks a stroma and produces curved or sometimes slightly sigmoid conidia.

Acknowledgements

We express our deep appreciation to Prof. Tian-Yu Zhang and Shoji Ohga for their valuable suggestions and earnest assistance in the course of submission of this manuscript.

Literature cited

- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series vol.1: 19-22
- Crous PW, Kang JC, Braun U. 2001. A phylogenetic redefinition of anamorph genera in *Mycosphaerella* based on ITS rDNA sequence and morphology. *Mycologia*. 93(6): 1081-1101.
- Singh SK, Chaudhary RK, Morgan-Jones G. 1995. Notes on Hyphomycetes. LXVII. Three new species of *Phaeoramularia* from Nepal. *Mycotaxon* 54: 57-66
- Deighton FC. 1979. Studies on *Cercospora* and allied genera. VII. New species and redispositions. *Mycol. pap.* No. 144: 32-45

MYCOTAXON

Volume 100, pp. 193–208

April–June 2007

Two new species of *Agaricus* from the Subantarctic

JÓZSEF GEML^{1*}, GARY A. LAURSEN¹,
HARRIS C. NUSBAUM² & D. LEE TAYLOR¹

*jgempl@iab.alaska.edu

¹*Institute of Arctic Biology, University of Alaska Fairbanks
Fairbanks, Alaska 99775-7000, U.S.A.*

²*Sequence and Analysis Program, Broad Institute
Cambridge, MA 02141, U.S.A.*

Abstract—Molecular and morphological data are presented for three *Agaricus* species on Campbell Island, New Zealand. Two of these are new species, *A. campbellensis* and *A. subantarcticus*. The third may be conspecific with *A. subrutilescens*, although the molecular data suggest a lack of gene flow between subantarctic and North American populations. Alternatively, it could be a closely related, but undescribed species. This is the first report of the *Subrutilescens* group from the Southern Hemisphere.

Key words— *Basidiomycota*, fungi, ITS, LSU, phylogenetics

Introduction

Agaricus L. is a diverse, cosmopolitan genus with an estimated 300 species worldwide (Cappelli 1984, Bas 1991). Recently, efforts have been made to reconstruct the evolutionary history of the genus from molecular data (Bunyard et al. 1996, Mitchell & Bresinsky 1999, Robison et al. 2001, Challen et al. 2003, Geml 2004, Geml et al. 2004) and to detect and describe new species using molecular and morphological data (Callac & Guinberteau 2005, Kerrigan 2005). Studies to date mostly have included European and North American taxa while those in the subantarctic regions remain largely unknown. Mitchell & Walter (1999) provided a taxonomic key to all known *Agaricus* species in New Zealand. Here we provide molecular phylogenetic analyses to reveal the evolutionary history of three *Agaricus* species from Campbell Island in the Subantarctic and use molecular and morphological data to describe two of these as new species.

Campbell Island (S 52° 33', E 169° 10') is located c. 300 km from the nearest land (Auckland Islands) and c. 650 km south of the main islands of New Zealand. Basement rocks of the island are composed of schist (dating from

640 Ma), Cretaceous sandstone, Tertiary limestone, and more recent volcanic flows. Deep peat is found in flat and gently sloping areas, while mineral content of the soil is more pronounced on steeper slopes (Campbell 1981, Foggo & Meurk 1983). Vegetation is predominantly tussock grassland, shrubland and herbfield divided into upper alpine, lower alpine, and subalpine zones (Meurk 1977). *Agaricus* collections were made in the shrubland to upper alpine zones characterized by dwarf forests of *Dracophyllum scoparium* and *D. longifolium*, with *Coprosma* and *Myrsine* species (Figs. 1, 2).

Methods and materials

Thirteen specimens were collected from the subantarctic Campbell Island (Table 1). Voucher specimens are deposited in the University of Alaska Fairbanks Herbarium (ALA) and in the New Zealand Fungal Herbarium (PDD). DNA was extracted from small samples of dried specimens using the E-Z 96® Fungal DNA Kit (Omega Bio-tek, Inc., Doraville, GA). ITS and LSU sequences of an additional thirty *Agaricus* species, representing the known diversity of the genus, were downloaded from GenBank (Table 1.). Homologous sequences of *Chlorophyllum molybdites* (U85309, U85303) were used to root all trees.

Table 1. Specimen code and GenBank accession numbers of *Agaricus* spp. included in this study.

Species	Collection number	GenBank accession number		Origin, reference
		ITS	LSU	
<i>A. campbellensis</i>	GAL9379	DQ232638	DQ232651	Campbell Island, New Zealand
	GAL9420	DQ232644	DQ232657	Campbell Island, New Zealand
	GAL9573	DQ232640	DQ232653	Campbell Island, New Zealand
	GAL9603	DQ232639	DQ232652	Campbell Island, New Zealand
	GAL9633	DQ232641	DQ232654	Campbell Island, New Zealand
	GAL9605	DQ232645	DQ232658	Campbell Island, New Zealand
	GAL9649	DQ232646	DQ232659	Campbell Island, New Zealand
<i>A. subantarcticus</i>	GAL9604	DQ232637	DQ232650	Campbell Island, New Zealand
	GAL9419	DQ232642	DQ232655	Campbell Island, New Zealand
	GAL9425	DQ232647	DQ232660	Campbell Island, New Zealand
	GAL9418	DQ232648	DQ232661	Campbell Island, New Zealand
	GAL9572	DQ232643	DQ232656	Campbell Island, New Zealand
<i>A. cf. subrutilescens</i>	GAL9422	DQ232649	DQ232662	Campbell Island, New Zealand
<i>A. abruptibulbus</i> Peck	-	AY484673	AY484673	Geml et al. (2004)
<i>A. albolutescens</i> Zeller	-	AY484675	AY484675	Geml et al. (2004)
<i>A. arvensis</i> Schaeff.	-	AY484691	AY484691	Geml et al. (2004)
<i>A. augustus</i> Fr.	-	AY484672	AY484672	Geml et al. (2004)



Figs. 1-2. Characteristic vegetation of the subalpine zone of Campbell Island: *Dracophyllum scoparium* and *D. longifolium* (shrub), *Poa litorosa* (tussock grass), *Polystichum vestitum* and *Histiopteris incisa* (ferns).

Table 1, concluded

Species	Collection number	GenBank accession number		Origin, reference
		ITS	LSU	
<i>A. bernardii</i> (Quél.) Sacc.	-	AY484678	AY484678	Geml et al. (2004)
<i>A. bisporus</i> (J.E. Lange) Imbach	-	AY484692	AY484692	Geml et al. (2004)
<i>A. bitorquis</i> (Quél.) Sacc.	-	AY484695	AY484695	Geml et al. (2004)
<i>A. blazei</i> Murrill	-	AY484697	AY484697	Geml et al. (2004)
<i>A. californicus</i> Peck	-	AY484679	AY484679	Geml et al. (2004)
<i>A. campestris</i> L.	-	U85307	U85273	Johnson & Vilgalys (1999)
<i>A. cupreobrunneus</i> (Jul. Schaeff. & Steer) Pilát	-	AY484680	AY484680	Geml et al. (2004)
<i>A. devoniensis</i> P.D. Orton	-	AJ418755	AF059225	Challen et al. (2003), Mitchell & Bresinsky (1999)
<i>A. diminutivus</i> Peck	-	AY484681	AY484681	Geml et al. (2004)
<i>A. excellens</i> (F.H. Møller) F.H. Møller	-	AY484682	AY484682	Geml et al. (2004)
<i>A. fissuratus</i> (F.H. Møller) F.H. Møller	-	AY484683	AY484683	Geml et al. (2004)
<i>A. fuscofibrillosus</i> (F.H. Møller) Pilát	-	AY484684	AY484684	Geml et al. (2004)
<i>A. fuscovelatus</i> Kerrigan	-	AY484677	AY484677	Geml et al. (2004)
<i>A. hondensis</i> Murrill	-	AY484685	AY484685	Geml et al. (2004)
<i>A. inapertus</i> Vellinga	-	AF482834	AF482878	Vellinga et al. (2003)
<i>A. langei</i> (F.H. Møller) F.H. Møller	-	AY484699	AY484699	Geml et al. (2004)
<i>A. liliceps</i> Zeller	-	AY484676	AY484676	Geml et al. (2004)
<i>A. macrocarpus</i> (F.H. Møller) F.H. Møller	-	AY484686	AY484686	Geml et al. (2004)
<i>A. macrosporus</i> (F.H. Møller & Jul. Schäff.) Pilát	-	AY484687	AY484687	Geml et al. (2004)
<i>A. nivescens</i> (F.H. Møller) F.H. Møller	-	AY484670	AY484670	Geml et al. (2004)
<i>A. pocillator</i> Murrill	-	AF041542	U85308	Hopple & Vilgalys (1999, Johnson & Vilgalys (1999)
<i>A. semotus</i> Fr.	-	AJ133390	AF059224	Challen et al. (2003), Mitchell & Bresinsky (1999)
<i>A. subfloccosus</i> (J.E. Lange) Hlaváček	-	AY484698	AY484698	Geml et al. (2004)
<i>A. subperonatus</i> (J.E. Lange) Singer	-	AF432889	AF059216	Challen et al. (2003), Mitchell & Bresinsky (1999)
<i>A. subrutilescens</i> (Kauffman) Hotson & D.E. Stuntz	-	AY484688	AY484688	Geml et al. (2004)
<i>A. xanthoderma</i> Genev.	-	AY484689	AY484689	Geml et al. (2004)

Table 2. Selected characteristics of subantarctic *Agaricus* spp. included in this study.

Species	UAF/ALA Collection	Spore dimensions (μm)		Spore shape	Schaeffer reaction	KOH reaction	Color change	Pileus (cm)	Stipe length $\times$ diameter (cm)
	number	length	width	Q-value			context		
<i>A. campbellensis</i>									
	GAL9379	8.74 ± 0.79	4.26 ± 0.25	1.93 ± 0.14	+	yellow	yellow, tan	3.5-4.0	4.0-5.5 $\times 0.8$
	GAL9420	7.06 ± 0.49	4.29 ± 0.34	1.69 ± 0.22	+	yellow	yellow	3.0-5.0	4.0-6.0 $\times 0.8-1.1$
<i>A. subantarcticus</i>									
	GAL9573	7.04 ± 0.66	4.48 ± 0.41	1.56 ± 0.17	+	yellow	N/A	N/A	N/A
	GAL9604	8.16 ± 0.64	4.86 ± 0.45	1.75 ± 0.22	+	yellow	N/A	N/A	N/A
<i>A. cf. subrutilescens</i>									
	GAL9419	7.78 ± 1.31	4.83 ± 0.28	1.68 ± 0.15	+	yellow	yellow	4.0-13.0	4.0-9.0 $\times 0.8-3.5$
	GAL9425	7.72 ± 1.25	4.80 ± 0.41	1.53 ± 0.32	+	yellow	yellow	7.0-8.0	4.0 $\times 1.5-2.0$
<i>A. cf. subrutilescens</i>	GAL9422	4.98 ± 0.69	3.21 ± 0.25	1.51 ± 0.19	-	olive green	none	6.0	6.0 $\times 0.9-1.5$

Symbols: + = present or positive, - = absent or negative, N/A = no data.

Spore dimensions and shape are given as mean $\pm$ standard deviation, based on twenty-five measurements per specimen.

The entire ITS and partial LSU regions were PCR amplified in reaction mixtures containing 1.75 µl Ultrapure Water (Invitrogen), 1 µl 10x Herculanase PCR buffer (Stratagene), 0.05 µl 100mM dNTP mixture, 25mM of each dNTP (Applied Biosystems), 0.2 µl Herculanase DNA polymerase (Stratagene), 2 µl of 1 µM forward primer, ITS1F (Gardes & Bruns 1993) and reverse primer, TW13 (White et al. 1990), and 3 µl of template DNA at a concentration of 0.1 ng/ µl. PCR reactions were performed using the following temperature program: 95 °C/2 min, 34 cycles of 95 °C/0.5 min, 54 °C/1 min, 72 °C/2 min; and 72 °C/10 min. The concentration of the amplification products was determined using Picogreen (Molecular Probes). The amplification products were normalized to a concentration of 4 ng/µl and sequenced using the Applied Biosystems (ABI) BigDye v. 3.1 terminator kit and an ABI 3730xl automated capillary DNA sequencer (Applied Biosystems, Foster City, CA). We used two internal primers for cycle sequencing, ITS4 and CTB6 (White et al. 1990), in addition to the primers used in the PCR reactions.

Sequence data obtained for both strands of each locus were edited and assembled for each isolate using Aligner v. 1.3.4 (CodonCode Corporation, Dedham, MA). Sequence alignments were initiated using Clustal W (Higgins et al. 1991) and subsequently corrected manually. Ambiguously aligned positions were recoded using INAASE 2.3b (Lutzoni et al. 2000) to retain the phylogenetic information present in the region without violating positional homology. The code matrix was attached to the alignment and was included in MP analyses. Phylogenetic analyses were conducted using the maximum-parsimony (MP) method in PAUP* 4b10 (Swofford 2002). MP analyses were carried out with the heuristic search option using the "tree bisection and reconnection" (TBR) algorithm with 100 random sequence additions to find the global optimum without limiting the maximum number of trees. Gaps were scored as "new state". The stability of clades was tested using the bootstrap test (Felsenstein 1985) with "full heuristic search" and 500 replications.

Fresh collections were described, photographed, and dried for later microscopic study. Specimens from three collections of each species were chosen for study. The ISCC-NBS Dictionary of Color Names was used to describe all combinations of basidiome color. Twenty-five basidiospores were measured from each specimen. Basidiospores, cheilocystidia and basidia were measured in 5% KOH using a 100× objective. Numerical data were analyzed by one-way analysis of variance (ANOVA) using JMP 3.2.6 (SAS Institute Inc.). Where the null-hypothesis was rejected, that all means were the same, Student's t-test (Ott 1993) was used to detect significant differences by testing each pair of means. Two chemical tests were performed on the pileus: the Schaeffer-reaction (using aniline and nitric acid) and the KOH-reaction. The Schaeffer-reaction was considered positive when the intersection of the two reagents became bright

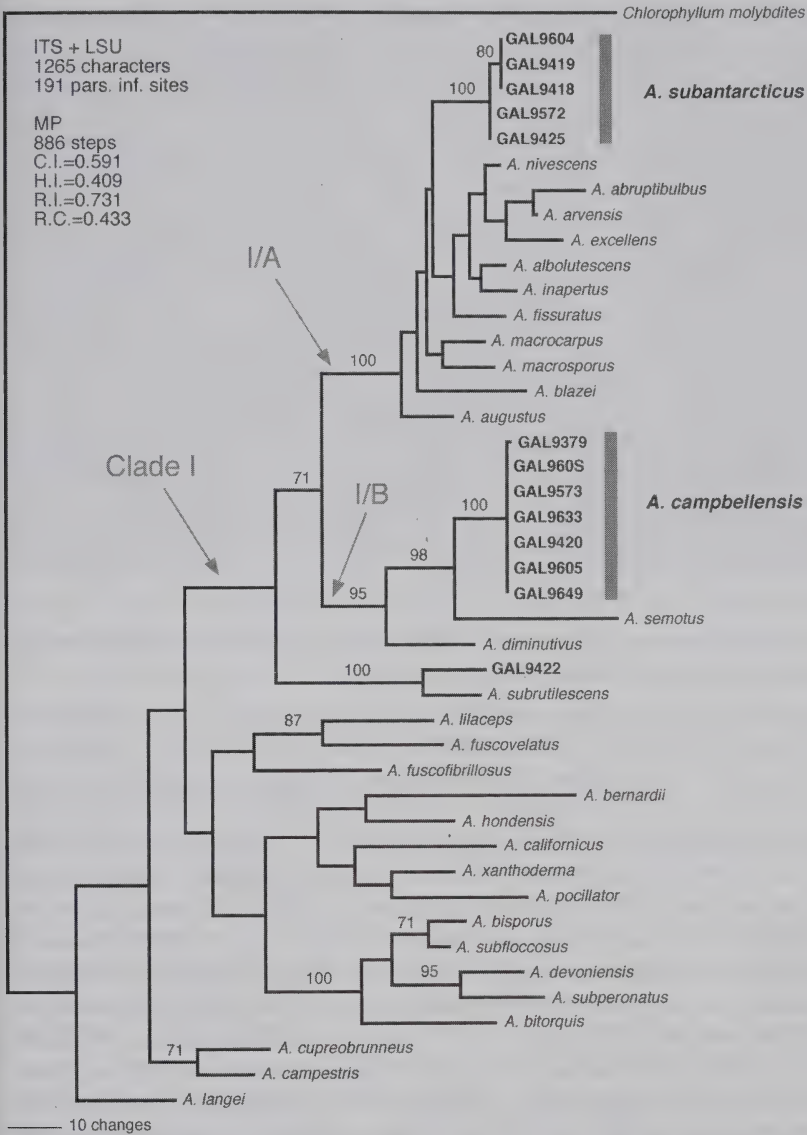


Fig. 3. Phylogram of *Agaricus* species based on maximum parsimony analyses of the combined (ITS, LSU) dataset. Bootstrap values are shown above the branches. Subantarctic isolates are in bold.

orange or red, while the KOH reaction was positive when yellow or green color was observed in the area of contact on the pileus surface.

Results

The combined ITS+LSU datasets of the 33 taxa consisted of 1414 characters, including gaps. Of these, 155 characters were excluded, containing ambiguous positions (235-239, 326-330, 558-568, 585-601, 719-731, 735-739) and incomplete data on both ends (1-44, 1360-1414). After including the character matrices of the ambiguous regions recoded by INAASE, the final alignment consisted of 1265 characters. The number of parsimony-informative sites was 191. One of the 3 most parsimonious trees is shown with bootstrap values in Fig. 3. The subantarctic specimens grouped in three species clades, all within Clade I (Geml et al. 2004) that corresponds to section *Arvenses* (Heinemann 1977). One specimen (GAL9422) formed a well-supported (100%) monophyletic clade with an *A. subrutilescens* specimen from North America. Seven specimens (GAL9379, GAL9420, GAL9573, GAL9603, GAL9605, GAL9633, GAL9649) had virtually identical ITS and LSU sequences and formed a new species clade, *A. campbellensis* with 100% bootstrap support. This species clade formed a sister clade to *A. semotus* in clade I/B (Geml et al. 2004) corresponding to subsection *Minores* (Heinemann 1977). The third species clade, *A. subantarcticus*, included five collections (GAL9418, GAL9419, GAL9425, GAL9572, GAL9604) and also received 100% support. Although confidently placed in Clade I/A with species of subsection *Arvenses* (Heinemann 1977), the closest relatives of this species could not be specified with statistical support.

Selected morphological characteristics of the three species of *Agaricus* found on Campbell Island are summarized in Table 2. Macro- and microscopic characteristics of the subantarctic *A. cf. subrutilescens* are in agreement with those traits specified by Kerrigan (1986) for *A. subrutilescens* in California. The only difference was in habitat: in California, *A. subrutilescens* is found in *Sequoia* and *Pseudotsuga* forests, while on Campbell Island *A. cf. subrutilescens* was found under *Dracophyllum* shrub in the subalpine zone. *Agaricus campbellensis*, represented by GAL9379, GAL9420, and GAL9573, showed relatively low variation in spore dimensions within specimens, similar to *A. cf. subrutilescens*. However, variation between specimens was sometimes great, for example, GAL9379 had much more elongated basidiospores ($P < 0.05$) than the other two collections. On the other hand, intraspecimen variation was substantial in *A. subantarcticus*, although statistically significant differences were not detected among collections. At the species level, basidiospore length values of *A. subantarcticus* and *A. campbellensis* were not significantly different, while the basidiospore width in *A. campbellensis* was significantly less than in *A. subantarcticus* ($P < 0.05$). Both newly described species shared characteristics with species in the section *Arvenses*, notably the presence of cheilocystidia, positive Schaeffer's reaction, yellow KOH reaction, yellowish change of context, and almond-like fragrance. *Agaricus subantarcticus* produces mid-



Fig. 4. *Agaricus* cf. *subrutilescens* (GAL9422). Scale bar equals 5 cm.

sized basidiomes with well-developed fibrillose patches on the pileus, while *A. campbellensis* has small basidiomes with tiny oppressed fibrils on the pileus.

Taxonomy

Agaricus cf. *subrutilescens* (Kauffman) Hotson & D.E. Stuntz

Figs. 4, 13

Pileus to 60 mm diam, broadly convex-umbonate; ground color orange to tan, radiating surface fibrils bronze to snuff brown (5E5-5F6); partial veil remnants on margin; context whitish, unchanging, to 5 mm thick. **Lamellae** to 5 mm broad, unequal in length, crowded, edges entire, free, thin; pinkish clay (5B2). **Stipe** 60 mm long, 9-15 mm thick at bulbous base; apex smooth; white (5A1), surface with floccose patches to base; context white, unchanging, stuffed to solid. Smell: sweet. Taste: nutty. **Partial veil** white, forming an inferior, membranous annulus. **Chemical reactions:** pileus cuticle olive green with 5% KOH, pileus context negative; Schaeffer reaction negative. **Microscopical characteristics:** Basidiospores: $4-6.2 \times 3-3.7 \mu\text{m}$, short to medium-elliptical, wall yellow to reddish-brown (5% KOH), smooth, thick, entire, apiculate; $Q=1.51 \pm 0.19$. Basidia: $18.5-23.3 \times 7-7.5 \mu\text{m}$, 4-spored. Clamps: lacking throughout. Subhymenium undifferentiated. Pileipellis of interwoven, inamyloid, cylindrical hyphae $2.6-12.3 \mu\text{m}$ in diam. Pileus context of interwoven, inamyloid, cylindrical hyphae $2.2-11 \mu\text{m}$ in diam. Lamellar trama of parallel to interwoven, inamyloid hyphae $4.4-22.9 \mu\text{m}$ in diam.

Habitat – On litter, under *Dracophyllum scoparium* in the subalpine belt.

Collection examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, TUCKER COVE (S52° 33', E169° 10') PDD92092, GAL9422, 9 March 2000, coll. G. A. Laursen, Specimen deposited in ALA.

Comments -- Although this taxon has a somewhat unique ITS sequence, it is likely conspecific with or very closely related to *A. subrutilescens* described from North America, this is supported by the phylogenetic analyses and the shared characteristics (green KOH reaction, negative Schaeffer reaction, small spore size, unchanging context, and brown, fibrillose pileus surface etc.). It is worth noting, however, that the ITS sequences of the two isolates are relatively distinct, suggesting some divergence between populations in North America and the subantarctic region. Future investigations involving a substantially larger sample size are needed to learn more about the population structure of the species. It appears that this is the first report of *Subrutilescens* group (Kerrigan 1986) from New Zealand as well as the Southern Hemisphere.

Agaricus campbellensis Geml, Laursen & D. Lee Taylor, sp. nov.

Figs. 5-8, 14

MYCOBANK # MB510665

Pileus 30-50 mm, convexus, forte convexo-planus, siccus, alutaceus, fibrillulae appressae, rufobrunneae, in margine fragmentis veli albis ornatus. *Lamellae* liberae, confertae, latae, e pallidis griseo- ad roseobrunneae, denique fuscae, inaequalis, exilis, acie sterili. *Stipes* 40-60 mm longus, 8-11 mm crassus, albidus, fibrillosus, basi clavata, attenuatus ad pileum, anguste fistulosus, superficies sicca, caro alba, mox griseolutescens. *Annulus* superus, albus, membranaceus, simplex. *Odore* amygdalino. *Sporae* ovatae, aliquando productae, monov- el biguttulatae, fuscae, (6-) 7-8.8 (-10) × 4-4.5 (-4.8) µm. *Basidia* bi- et tetrasporigera, (20.2-) 21.1-24.6 × (6.6-) 7.0 µm. *Typus*: New Zealand, Campbell I.: Perseverence Harbour, Tucker Cove (S52° 33.1', E169° 9.3'), infra *Dracophyllum scoparium*, *D. longifolium*, et *Polystichum vestitum* in zona alpina et subalpina, 9 Mar 2000, coll. Gary A. Laursen, holotypus PDD92093, isotypus GAL9420 in herbario ALA depositur.

Etymology -- The name refers to the type locality.

Pileus 30-50 mm diam, convex to plano-convex, surface dry, tan (5A2, orange white) with appressed, clay or mustard brown (5D5, 5E6) fibrils, margin with veil remnants. **Lamellae** 4.5 mm broad, pinkish to pale grayish brown (5C3, 5D4, 5D5) at first, later dark brown (5E4, 5E5), free, crowded, unequal in length, thin. **Stipe** 40-60 mm long, 8-11 mm thick, whitish with yellow-brown fibrils (3A6, 3A7, 4A6, 4A7), base swollen, tapering toward the pileus, dry, context hollow, white, turning a marbled yellow, tan or grey. **Odor and taste**: almond. **Partial veil** white forming an inferior, membrane-like annulus, evanescent in age. **Chemical reactions**: pileus context and surface yellowing in 5% KOH; Schaeffer reaction positive. **Microscopical characteristics**: Basidiospores short to medium-elliptical, sometimes elongated, yellow to reddish-brown, wall smooth, thick, entire, apiculate, one- or two-guttulate, dark brown at maturity, (6-) 7-8.8 (-10) × 4-4.5 (-4.8) µm, mean and standard deviation are: $L\ 7.61 \pm 1.03$,

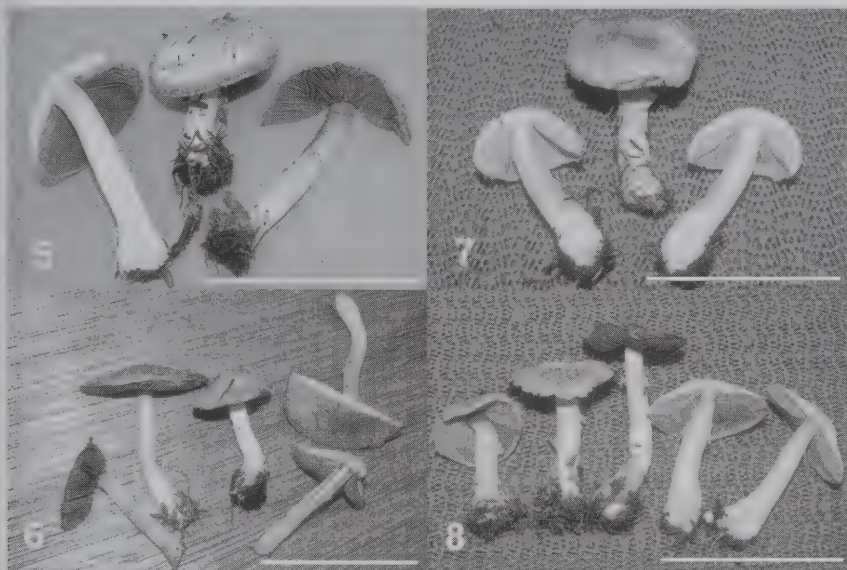


Fig. 5-8. *Agaricus campbellensis*. 5. GAL9379. 6. GAL9420. 7. GAL9573. 8. 9605.
Scale bar equals 5 cm.

W 4.34 ± 0.34 ; Q 1.69 ± 0.22 . Basidia: 2-4-spored, $(20.2-)$ $21.1-24.6 \times (6.6-)$ $7.0 \mu\text{m}$, clavate. Subhymenium of irregular, swollen, inamyloid cells. Pileipellis of interwoven, inamyloid, cylindrical hyphae, terminal cells cylindrical to slightly swollen tipped. Pileus context of interwoven, inamyloid, cylindrical hyphae. Lamellar trama of parallel to interwoven, inamyloid hyphae.

Characteristic fixed ITS rDNA polymorphisms. Characteristic fixed DNA polymorphisms were determined based on the sequence alignments used in the phylogenetic analyses. Only those characters present in all *A. campbellensis* isolates and not present in *A. semotus*, the most closely related known *Agaricus* species, were included. These fixed DNA polymorphisms are indicated with capital and italicized letters (nucleotides) or italicized numbers (gaps) with the alignment position given: tctT[-1-]tag @ 81-82; gggTat[-2-]Cgag @ 154, 157-159; aggTggtcAGcct @ 167, 172-173; ttTgct @ 189; tgtGagg @ 199; gctTtgc @ 222; tgaCccc @ 242; gttTA[-1-]ctTGcCaga @ 255-256, 260-261, 263; gtCGaat @ 296-297; cttTgaa @ 306; tctTtac @ 315; catGggc @ 321; tt[-1-]T[-1-]catgCcta @ 328, 334; aatCata[-2-]ata @ 346, 350-351; aacGcag @ 400; aaaGgca @ 617.

Habitat -- On litter, under *Dracophyllum scoparium*, *D. longifolium*, and *Polystichum vestitum* in the subalpine and alpine zones.

Collections examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERANCE HARBOUR, TUCKER COVE (S52° 33.1', E169° 9.3') PDD92093 (Holotype), GAL9420 (Isotype), 9 March 2000, coll. G. A. Laursen; same location GAL9379, 6 March 2000, coll. G. A.

Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT HONEY (S52° 33.5', E169° 8.9') GAL9573, GAL9603, 14 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT BEEMAN (S52° 33.7', E169° 9.2') GAL9605, GAL9633, GAL9649, 15 March 2000, coll. G. A. Laursen. Specimens deposited in ALA.

Comments -- Based on both molecular and morphological data, *Agaricus campbellensis* is placed in section *Arvenses*, subsection *Minores*. It differs from its closest known relative, *A. semotus* for which the name *A. dulcidulus* Schulzer was proposed (Nauta 2001), in particular by multiple ITS rDNA polymorphisms (see species description), much larger basidiospore size, the presence of two-guttulate basidiospores, and the color of the pileus. Although there are several other described species in this subsection with no available genetic data (e.g. *A. comtulus* Fr., *A. lutosus* (F.H. Møller) F.H. Møller, *A. purpurellus* (F.H. Møller) F.H. Møller, *A. luteomaculatus* (F.H. Møller) F.H. Møller, *A. xantholepis* (F.H. Møller) F.H. Møller), *A. campbellensis* clearly differs from these in morphology (i.e. spores size and pileus color). Similarly, the three *Minores* species specified by Mitchell & Walter (1999) to occur in New Zealand (i.e. *A. bambusae* var. *australis* Heinem., *A. semotus*, and *A. viridopurpurascens* Heinem) differ from *A. campbellensis* in the characters specified above.

Agaricus subantarcticus Geml, Laursen & D. Lee Taylor, sp. nov. Figs. 9-12, 15
MYCOBANK # MB510667

Pileus 40-130 mm, *convexus, forte convexo-planus, albolutescens vel cremeus, denique melleus*. *Disco et squamuli fibrillosi cremei vel griseobrunnei, denique rufobrunnei, in margine fragmentis veli albis ornatus*. *Lamellae liberae, confertae, latae, e pallidis griseo-ad roseobrunneae vel aurantiobrunneae, denique fuscae, inaequalis, fragilis, acie sterili*. *Stipes* 40-90 mm × 8-20 mm, *albus, tactu lutescens, basi clavata (25-35 mm), anguste fistulosus, glabrus, caro alba, mox lutescens*. *Annulus inferior, albus, membranaceus, reflexus*. *Odore amygdalino*. *Sporae ovatae, fuscae, mono- vel biguttulatae, (4-) 7-9 (-9.5) × (4-) 4.5-5.5 µm*. *Basidia tetrasporigera, 8.8 × 17.6 µm*. *Typus: New Zealand, Campbell I.: Perseverence Harbour, Tucker Cove (S52° 33.1', E169° 9.3'), infra Dracophyllum scoparium et D. longifolium in zona subalpina, 9 Mar 2000, coll. Gary A. Laursen et H. H. Burdsall, holotypus PDD92094, isotypus GAL9419 in herbario ALA depositur*.

Etymology -- The name refers to the geographic region, in which the species is found.

Pileus 40-130 mm diam, convex to plano-convex, surface yellow white (4A2) to cream or chamois (4A3, 4B4, 4C5) at first, later topaz or honey yellow (5C5, 5D6, 5E7). Disc and fibrillose squamules cream to grayish tan at first, later reddish brown (5D5, 5E6), margin with veil remnants. ***Lamellae*** 4-15 mm broad, pinkish to orange brown and pale grayish brown (5B2, 5C3, 5D4) at first, later dark brown (5E4, 5E5, 5F6), free, crowded, unequal in length, brittle. ***Stipe*** 40-90 mm long, 8-20 mm thick, white or dull yellow, base bulbous (25-35 mm thick), smooth, context hollow, white, turning yellow. Odor and taste: almond. ***Partial veil*** white forming an inferior, membrane-like, annulus, evanescent in



Fig. 9-12. *Agaricus subantarcticus*. 9. GAL9604. 10. GAL9419. 11-12. GAL9425.
Scale bar equals 5 cm.

age. **Chemical reactions:** pileus context and surface yellowing in 5% KOH; Schaeffer reaction positive. **Microscopical characteristics:** Basidiospores short to medium-elliptical, yellow to reddish-brown; wall smooth, thick, entire, apiculate, chocolate brown to purple brown in deposit, one- or two-guttulate, exhibit great variation in size within specimen, $(4-) 7-9 (-9.5) \times (4-) 4.5-5.5$ μm , mean and standard deviation are: $7.89 \pm 1.11 \times 4.83 \pm 0.38$; $Q = 1.69 \pm 0.15$. Basidia: mostly 4-spored, 8.8×17.6 μm , clavate. Subhymenium of irregular, swollen, inamyloid cells. Pileipellis of interwoven, inamyloid, cylindrical hyphae, terminal cells cylindrical to slightly swollen tipped. Pileus context of interwoven, inamyloid, cylindrical hyphae. Lamellar trama of parallel to interwoven, inamyloid hyphae.

Characteristic fixed ITS rDNA polymorphisms. Characteristic fixed DNA polymorphisms were determined based on the sequence alignments used in the phylogenetic analyses. Only those characters present in all *A. subantarcticus* isolates and not present in any other species in Clade I/A sensu Geml et al. (2004) were included. These fixed DNA polymorphisms are indicated with capital and italicized letters (nucleotides) or italicized numbers (gaps) with the alignment position given: tagGgag @ 159; aagCggt @ 167; catActa @ 174; ctgCcct @ 228; ctcGcca @ 261; tgtTatt @ 275; tacCct @ 289.

Habitat -- On litter, under *Dracophyllum scoparium* and *D. longifolium* in the subalpine zone of subantarctic islands.

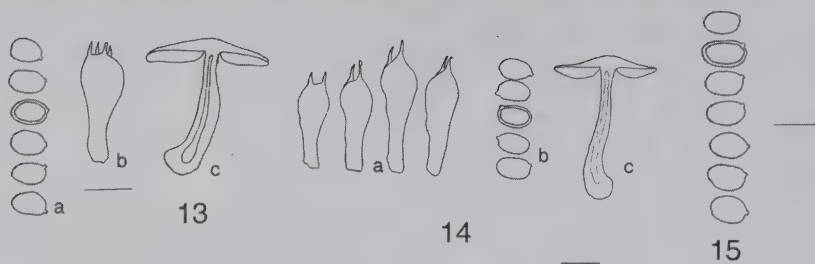


Fig. 13-15. 13. Basidiospores (a), basidium (b), and cross section of mature basidiocarp (c) of *Agaricus* cf. *subrutilescens* (GAL9422). 14. Basidia (a), basidiospores (b), and cross section (c) of mature basidiocarp of *Agaricus campbellensis* (GAL9420). 15. Basidiospores of *Agaricus subantarcticus* (GAL9419). Scale bar equals 10 µm.

Collections examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, TUCKER COVE (S52° 33.1', E169° 9.3') PDD92094 (Holotype), GAL9419 (Isotype), 9 March 2000, coll. G. A. Laursen and H. H. Burdsall; same location and date GAL9418, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR (S52° 33.2', E169° 10.1') GAL9425, 10 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT HONEY (S52° 33.5', E169° 8.9') GAL9572, 14 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT BEEMAN (S52° 33.7', E169° 9.2') GAL9604, 15 March 2000, coll. G. A. Laursen. Specimens deposited in ALA.

Comments -- Based on molecular and morphological data, *A. subantarcticus* is placed in section *Arvenses*, subsection *Arvenses*. The cream then honey-brown colored pileus, the relatively large fibrillose squamules, and the characteristic inferior position of the annulus are unique among known species in the section *Arvenses*. Although species with brown scales are found in the section (e.g. *A. augustus*, *A. subrufescens* Peck), the squamules are much larger in *A. subantarcticus* and sometimes less pronounced, particularly in older specimens. Also these species are very different phylogenetically as well. Superficially similar pilei can be observed in *A. romagnesii* Wasser; however, this latter species is obviously different in many other aspects (ITS sequence, negative Schaeffer reaction, phenolic odor, etc.). There are three species in subsection *Arvenses* sensu Mitchell & Walter (1999) in New Zealand (i.e. *A. arvensis*, *augustus*, and *A. lanipes* (F.H. Møller & Jul. Schäff.) Hlaváček) and they clearly differ from *A. campbellensis* in both molecular and morphological characters.

Acknowledgments

This research was supported by NSF (grant no. 0333308) to D.L. Taylor, G.A. Laursen and others, and by a University of Alaska Presidential International Polar Year Postdoctoral Fellowship to J. Geml. Also, J. Geml is grateful to Deep Hypha (NSF 0090301) research

coordination support. This work was also supported by the Alaska EPSCoR (NSF grant no. EPS-0346770) and the Alaska INBRE (NIH NCRR grant no. 2P20RR16466). The authors also thank Joseph F. Ammirati and Cheryl Grgurinovic for their constructive reviews.

Literature cited

- Bas C. 1991. A short introduction to the ecology, taxonomy and nomenclature of the genus *Agaricus*. In: Van Griensven LJLD, ed. Genetics and breeding of *Agaricus*. Proceedings of the First International Seminar on Mushroom Science, Pudoc Wageningen pp 21–24.
- Bunyard BA, Nicholson MS, Royse DJ. 1996. Phylogeny of the genus *Agaricus* inferred from restriction analysis of enzymatically amplified ribosomal DNA. *Fungal Genet Biol* 20: 243–253.
- Callac P, Guinberteau J. 2005. Morphological and molecular characterization of two novel species of *Agaricus* section *Xanthodermatei*. *Mycologia* 97:416–424.
- Calvo-Bado L, Noble R, Challen MP, Dobrovin-Pennington A, Elliott TJ. 2000. Sexuality and genetic identity in the *Agaricus* Section *Arvenses*. *Appl Environ Microbiol* 66:728–734.
- Campbell IB. 1981. Soil pattern of Campbell Island. *New Zeal J Sci* 24:11–35.
- Cappelli A. 1984. *Agaricus* L.: Fr., *Fungi Europaei*, Vol. 1, Libreria editrice Biella Giovanna, Saronno, Italia. 560 p.
- Challen MP, Kerrigan RW, Callac P. 2003. A phylogenetic reconstruction and emendation of *Agaricus* section *Duploannulatae*. *Mycologia* 95:61–73.
- Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39:783–791.
- Foggo MN, Meurk CD. 1983. A bioassay of some Campbell Island soils. *New Zeal J Ecol* 6: 121–124.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity of basidiomycetes: application to the identification of mycorrhizae and rusts. *Mol Ecol* 2:113–118.
- Geml J. 2004. Evolution in action: Molecular evidence for recent emergence of secotiid genera *Endoptychum*, *Gyrophragmium* and *Longula* from *Agaricus* ancestors. *Acta Microbiol Immunol Hung* 51:97–108.
- Geml J, Geiser DM, Royse DJ. 2004. Molecular evolution of *Agaricus* species based on ITS and LSU rDNA sequences. *Mycol Progress* 3:157–176.
- Heinemann P. 1977. Essai d'une clé de détermination des genres *Agaricus* et *Micropsalliota*. *Sydowia* 30:6–37.
- Higgins DG, Bleasby AJ, Fuchs A. 1991. CLUSTAL W: improved software for multiple sequence alignment. *CABIOS* 8:189–191.
- Kerrigan RW. 1986. The *Agaricales* (Gilled Fungi) of California: 6. *Agaricaceae*. Mad River Press, Eureka, California. 62 p.
- Kerrigan RW. 2005. *Agaricus subrufescens*, a cultivated edible and medicinal mushroom, and its synonyms. *Mycologia* 97:12–24.
- Kerrigan RW, Callac P, Xu J, Noble R. 1999. Population and phylogenetic structure within the *Agaricus subfloccosus* complex. *Mycol Res* 103:1515–1523.
- Lutzoni F, Wagner W, Reeb V, Zoller S. 2000. Integrating ambiguously aligned regions of DNA sequences in phylogenetic analyses without violating positional homology. *Syst Biol* 49: 628–651.
- McKenzie EHC, Foggo MN. 1989. Fungi of New Zealand sub-antarctic islands. *New Zeal J Bot* 27:91–100.

- Meurk CD. 1977. Alien plants in Campbell Island's changing vegetation. *Mauri Ora* 5:93–118.
- Mitchell AD, Bresinsky A. 1999. Phylogenetic relationships of *Agaricus* species based on ITS-2 and 28S ribosomal DNA sequences. *Mycologia* 91:811–819.
- Mitchell AD, Walter M. 1999. Species of *Agaricus* occurring in New Zealand. *New Zeal J Bot* 37:715–725.
- Nauta MM. 2001. 1. *Agaricus* L. *Flora Agaricina Neerlandica* 5:23–61.
- Ott RL. 1993. An introduction to statistical methods and data analysis. 4th ed. Duxbury Press, Belmont, CA.
- Robison MM, Chiang B, Horgen PA. 2001. A phylogeny of the genus *Agaricus* based on mitochondrial atp6 sequences. *Mycologia* 93:30–37.
- Swofford DL. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods), 4.0b4a. Sinauer Associates, Sunderland, MA.
- Vellinga EC, De Kok RPJ, Bruns TD. 2003. Phylogeny and taxonomy of *Macrolepiota* (*Agaricaceae*). *Mycologia* 95:442–456.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. *PCR Protocols: A Guide to Methods and Applications*. Academic Press, Inc., New York, p 315–322.

Re-examinations of *Botryosphaeriaceae* (*Dothideomycetes*) from China on deposit in HMAS

WEN-YING LI^{1,2} & WEN-YING ZHUANG^{1*}

*zhuangwy@sun.im.ac.cn

¹Key Laboratory of Systematic Mycology and Lichenology
Institute of Microbiology, Chinese Academy of Sciences, Beijing 100101, China

²Graduate University of Chinese Academy of Sciences
Beijing 100049, China

Abstract—Specimens of the *Botryosphaeriaceae* from China on deposit in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences were re-examined. Fifteen species were identified including an anamorphic fungus. Six taxa of *Guignardia* are treated as new species. Three species are recorded for the first time from China.

Key words—taxonomy, nomenclature, valid publication

Introduction

Members of the *Botryosphaeriaceae* are common throughout the world and occur mostly on dead or declining plants. Many of them are known as plant pathogens. Early records of *Botryosphaeria* Ces. & De Not. and related fungi from China were reported by Teng (1934) and Sawada (1943a, b, c, 1944). Later discoveries of the group up to the 1980's were summarized by Sawada (1959), Teng (1963, 1996), Huang (1977) and Tai (1979). Recent studies were carried out by Eriksson & Yue (1988) and Hyde (1995). Collections including the authentic material studied by the early mycologists were mostly on deposit in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS). In connection with our current studies on the dothidealean fungi from China, specimens of the *Botryosphaeriaceae* on deposit in HMAS were re-examined. Fifteen species belonging to *Botryosphaeria*, *Fusicoccum*, *Dothidotthia* and *Guignardia* were recognized. Following Kirk et al. (2001), we accept *Guignardia* as a member of the *Botryosphaeriaceae* even though

* Author for correspondence.

some authors have different opinions on its taxonomic placement. Several of Sawada's names were not validly published according to the International Code of Botanical Nomenclature (Greuter et al. 2000) and validations of these names are provided. Three species are new records for China.

Material and methods

Thirty-eight collections previously treated as members of the *Botryosphaeriaceae* on deposit in HMAS were re-examined. Among them, two specimens filed under *Botryosphaeria ribis* were based on mis-identifications and are not botryosphaeriaceous. Specimens labeled as *Dothidotthia aspera* (HMAS 90270), *Guignardia caricae* Sawada (HMAS 11693), *Guignardia cephalanthae* Sawada (HMAS 05306, 11694), *Guignardia coffeana* (F. Noack) Sawada (HMAS 11696), *Guignardia hibisci-sabdariffae* Sawada (HMAS 05304, 11691), *Guignardia pruni-persicae* Sawada (HMAS 11697) and *Montagnellina calami* Sawada (HMAS 11733) proved to be too scanty to study. Anamorphs associated with teleomorphs on substrates were also observed. Squash mounts and sections were examined. Methods used follow Barr (1987). New records for China are marked with an asterisk (*).

Taxonomy

Botryosphaeria cunninghamiae T.Z. Huang, Acta Microbiol. Sin. 17(4): 304, 1977.

Specimens examined: CHINA. Fujian: Nanping, on branches of *Cunninghamia lanceolata* (Lamb.) Hook., 6.V.1976, T.Z. Huang 765062-3, HMAS 37190 (holotype); Tongan, on branches of *Cunninghamia lanceolata*, 7.V.1975, T.Z. Huang & D.Y. Chen 575017, HMAS 37191.

Notes: This species is easily recognized by the ellipsoid ascospores and catenulate ascomata. Huang (1977) provided detailed description and illustrations of the fungus. Re-examinations of the holotype and HMAS 37191 reveal that the asci and ascospores are somewhat shorter and narrower than those reported by the original author (asci $72-129 \times 17.5-27.5 \mu\text{m}$ vs. $93-150 \times 23-28 \mu\text{m}$, ascospores $15.5-24.5 \times 8.9-12.2 \mu\text{m}$ vs. $22-26 \times 12-15 \mu\text{m}$).

Botryosphaeria dothidea (Moug. ex Fr.) Ces. & De Not., Comment. Soc. Crittog. Ital. 1: 212, 1863.

= *Sphaeria dothidea* Moug. ex Fr., Syst. Mycol. 2: 423, 1823.

= *Botryosphaeria berengeriana* De Not., Sfer. Ital. 82, 1864.

Specimens examined: CHINA. Beijing: on twigs of *Cotinus coggygria* Scop., 12.VIII.1964, Y.N. Yu & G.Z. Jiang 1818, HMAS 34007; *ibid.*, Y.N. Yu & G.Z. Jiang 1817, HMAS 34075; on dead twigs, 19.IV.1950, G.Z. Jiang, HMAS 11998 (filed under *Botryosphaeria fuliginosa*). Shaanxi: Xi'an, on bark of dead tree, 25.IX.1963, Q.M. Ma & Y.C. Zong 3369, HMAS 33600; Taibaishan, 18.IV.1963, Q.M. Ma & Y.C. Zong 2022, HMAS 33564.

Shandong: Qingdao, bark of *Chionanthus retusus* Lindl., 1965, Q.Y. Zhang, HMAS 35803. Liaoning: Beining, on bark of *Prunus armeniaca* L., 30.VII.1955, S.J. Han, HMAS 19101 (filed under *Botryosphaeria ribis*).

Notes: This is the most common *Botryosphaeria* species in China. Slippers et al. (2004) provided a detailed description of the fungus. The conidiomata are often on the same stroma with the ascomata, aggregated and confluent except for those of HMAS 35803. HMAS 11998 differs slightly from the typical material in the narrower ascospores ($5.5\text{--}7.8\text{ }\mu\text{m}$ vs. $6\text{--}10\text{ }\mu\text{m}$ in width) with fewer guttules and less-interconnected pseudothecia (Slippers et al. 2004). We treat the above distinctions as infraspecific variations. The anamorphic *B. dothidea* is *Fusicoccum aesculi* (Slippers et al. 2004).

Following the taxonomic treatment by Arx & Müller (1954) and based on information provided in Sylloge Fungorum Sinicorum (Tai 1979), the Chinese record of *Botryosphaeria fuliginosa* (Ellis & Everh. was listed as *B. quercuum* (Schwein.) Sacc. by Eriksson & Yue (1988). Our examination of HMAS 11998 reveals that it does not fit the description of *B. quercuum* by Shoemaker (1964) in having a different ascospore shape [$19\text{--}29 \times 5.5\text{--}7.8\text{ }\mu\text{m}$ vs. $(28\text{--})30\text{--}33\text{--}(35) \times (12\text{--})14\text{--}15\text{--}(16)\text{ }\mu\text{m}$] but does fit the description of *B. dothidea*.

**Botryosphaeria* cf. *parva* Pennycook & Samuels, Mycotaxon 24: 455, 1985.

Specimen examined: CHINA. Beijing: on twigs of *Robinia pseudoacacia* L., 19.IV.1950, G.Z. Jiang, HMAS 11997 (filed under *Botryosphaeria abrupta*).

Notes: The fungus is characterized by ascomata immersed to erumpent, solitary to botryose, individual locules $134\text{--}203\text{ }\mu\text{m}$ in diam.; asci clavate, stipitate, $68\text{--}103 \times 13.5\text{--}17.5\text{ }\mu\text{m}$; and ascospores ellipsoid to broadly fusoid, $17.8\text{--}26 \times 6.3\text{--}8.8\text{--}(11.3)\text{ }\mu\text{m}$ (length/width ratio of 2.3), hyaline, unicellular, rarely 1- or 2-septate, thin-walled, smooth, guttulate. Its morphological features indicate that it is close to *B. parva* commonly found in the southern hemisphere in ascospore shape but with slightly larger l/w ratio (2.3 vs. 2.2) (Pennycook & Samuels 1985). We tentatively treat it as *B. cf. parva*. This is a new record for China.

Botryosphaeria rhodina (Berk. & M.A. Curtis) Arx, Gen. Fungi Sporul. Cult.: 143, 1970.

Specimen examined: CHINA. Shaanxi: Taibaishan, on twigs of *Pueraria* sp., 6.X.1963, Q.M. Ma & Y.C. Zong 3418, HMAS 33601 (filed under *Botryosphaeria dothidea*).

Notes: The fungus has much larger and thick-walled ascospores ($26.8\text{--}36.5 \times 8.3\text{--}12.4\text{ }\mu\text{m}$ vs. $19\text{--}24 \times 6\text{--}10\text{ }\mu\text{m}$) than those of *Botryosphaeria dothidea* and thick-walled ascomata which indicates that *B. rhodina* is the correct name (Sivanesan 1984). The species was previously reported from Taiwan Province and Hong Kong (Wang et al. 1999, Lu et al. 2000).

Botryosphaeria ribis Grossenb. & Duggar, Tech. Bull. N.Y. Agric. Exp. Sta. 18: 183, 1911.

Specimen examined: CHINA. Jiangsu: Paohuashan, on dead twigs, 27.IV.1930, H.N. Shen, HMAS 08902 (filed under *Botryosphaeria berengeriana*).

Notes: *Botryosphaeria ribis* seems widespread in China and was recorded from ten provinces (Tai 1979). But specimens filed under this name on deposit in HMAS are either based on mis-identifications or anamorphic.

Botryosphaeria berengeriana and *B. ribis* were both treated as synonyms of *B. dothidea* by Arx & Müller (1954). Eriksson & Yue (1988) accepted their taxonomic treatment and listed *B. dothidea* as the correct name for *B. ribis*. Following the treatment by Slippers et al. (2004), we recognize two separate species. The ascospores of HMAS 08902 are fusoid to ellipsoid, often with rounded ends and $15\text{--}24.5 \times 6\text{--}8.9 \mu\text{m}$. The morphology of the fungus fits better that of *B. ribis* (Slippers et al. 2004).

**Fusicoccum aesculi* Corda, in Sturm, Deutschl. Fl., Abth. 3, 2: 111, 1829.

Specimens examined: CHINA. Heilongjiang: Haerbin, on bark of dead tree, IV.1964, C.D. Xiang 22, HMAS 34042 (filed under *Botryosphaeria dothidea*). Liaoning: Xingcheng, on twigs of *Malus pumila* Mill., 10.VII.1955, B.N. Jiang & S.J. Han, HMAS 10372 (filed under *Botryosphaeria ribis*); Xiongyue, *Malus pumila*, VII.1955, R.F. Chen, HMAS 19100 (filed under *B. ribis*).

Notes: Ascomata and asci are not found but an anamorphic fungus. The diagnostic features are as follows: Conidiomata mostly solitary, occasionally aggregated and confluent in a single stroma, black externally, conidiomatal walls of textura angularis, composed of thick-walled outer cells, becoming paler and thin-walled towards the inner; conidia fusiform to narrowly fusiform, straight, subobtuse at apex, truncate and bearing a minute marginal frill at base, $16.7\text{--}27.8 \times 4\text{--}5.6 \mu\text{m}$ (length/width ratio of 4.3–5), hyaline, unicellular, thin-walled, smooth. The above features indicate its correct identification as *Fusicoccum aesculi*, anamorph of *B. dothidea*.

**Dothidotthia aspera* (Ellis & Everh.) M.E. Barr, Mycotaxon 34: 519, 1989.

Specimens examined: CHINA. Xinjiang: Urumqi, on twigs of shrubs, 9.VII.1991, Z.Q. Yuan 910339, HMAS90271; Urumqi, on twigs of *Lonicera* sp., 10.V.1991, Z.Q. Yuan 910212, HMAS 90273.

Notes: This is the correct name for the type species of *Dothidotthia* Höhn., *D. symphoricarpi* (Rehm) Höhn. The two Chinese collections on deposit in HMAS and correctly identified by the collector are identical in morphology and fit the description of the fungus by Barr (1989). This fungus is a new record for China.

Guignardia calami (Syd.) Arx & E. Müll., Beitr. Kryptfl. Schweiz 11(1): 55, 1954.
= *Guignardia arecae* Sacc., Notae Mycol. 23: 63, 1917.

Specimen examined: CHINA. Taiwan: Taibei, Jiaoxi, on leaves of *Areca catechu* L., 28.VII.1944, 9307, HMAS 05307 (filed under *Guignardia arecae*).

Notes: *Guignardia arecae* was reported by Sawada (1943b) from Taiwan and the correct name for the fungus is *G. calami* (Arx & Müller 1954, Sivanesan 1984). It was also found in Hong Kong (Hyde 1995).

Guignardia camelliae (Cooke) E.J. Butler, in Petch, Diseases Tea Bush: 192. 1923.

Specimen examined: CHINA. Zhejiang: Hangzhou, on leaves of *Thea sinensis* L., 20.V.1954, Zhejiang Agricultural College, HMAS 17193.

Notes: This is a common *Guignardia* species in China (Teng 1963, Tai 1979).

Guignardia fici Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.**

Figs. 1–4

MYCOBANK # MB 510673.

[*Montagnellina fici* Sawada, J. Taihoku Soc. Agric. 7(2): 125, 1943 ('1942'). ICBN Art. 36.1, not validly published.]

Pseudotheciis foliocolis, subglobose, ostiolatis, 117–174 µm diam, 75–128 µm altis; ascis bitunicatis, 8-sporis, 38–55 × 7–13.8 µm; ascosporis unicellularibus, ellipsoideis vel fusoides, 6–13 × 3–5.3 µm.

Leaf spots up to 2–8 mm diam., rounded, outer region yellow-brown, inner region necrotic and pea green. Pseudothecia forming under spherical, raised, darkened dots in the leaf spots, solitary; in vertical section 117–174 µm diam., 75–128 µm high, subglobose, immersed, with a central ostiole, 18 µm. Peridium thin, composed of a few layers of brown pseudoparenchymatous angular cells 4.7–12.4 µm diam. Asci 38–55 × 7–13.8 µm, 8-spored, broadly cylindrical or clavate, with a short stalk, bitunicate, broadly rounded above. Ascospores ellipsoid to fusoid, 6–13 × 3–5.3 µm, 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, Zhishanyan, on leaves of *Ficus nervosa* Heyne, 3.IV.1914, Y. Fujikuro, HMAS 11656. **Paratype:** *ibid.*, HMAS 05351.

Notes: When *Montagnellina fici* was first described, Sawada did not provide a Latin diagnosis for the fungus. According to the International Code of Botanic Nomenclature (ICBN) (Greuter et al. 2000), this name was not validly published. Both collections on deposit in HMAS are identical in morphology and match well the description of the fungus by Sawada (1943a). The morphology of the fungus indicates that it should be a member of *Guignardia* (Sivanesan 1984). In agreement with the treatment by Arx & Müller (1954), *Montagnellina* Höhn. should be a synonym of *Guignardia* Viala & Ravaz. A new species of *Guignardia* is proposed here.

Morphologically, *G. dioscoreae* A.K. Pande on *Dioscorea* is similar to *G. fici* in size of asci and of ascospores but produces much larger leaf spots (10 mm vs. 2–8 mm diam.) with slightly elevated rim and much smaller pseudothecia (60–130 μm vs. 117–174 μm diam.) (Aa 1973).

***Guignardia fici-septicae* Sawada, W.Y. Li & W.Y. Zhuang, sp. nov.**

Figs. 5–6

MYCOBANK # MB 510674.

[*Guignardia fici-septicae* Sawada, J. Taihoku Soc. Agric. 7(2): 123, 1943 ('1942'). ICBN Art. 36.1, not validly published.]

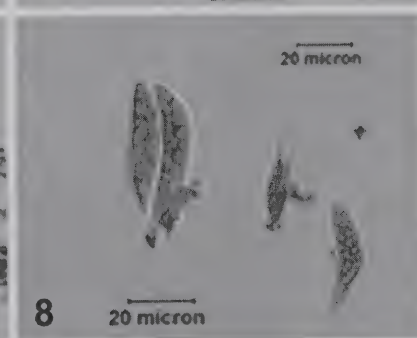
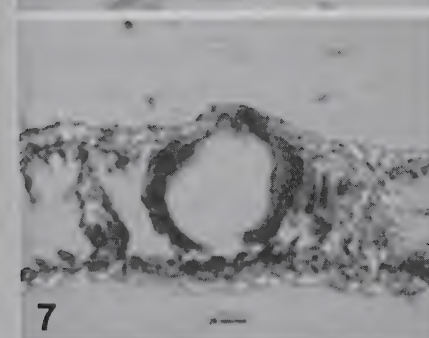
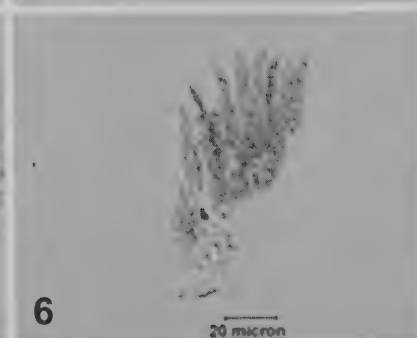
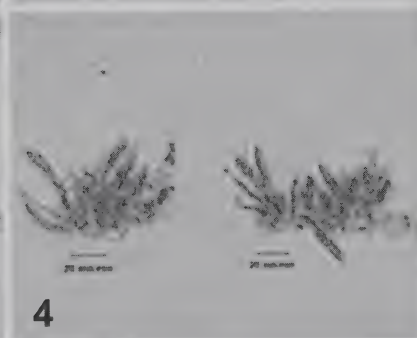
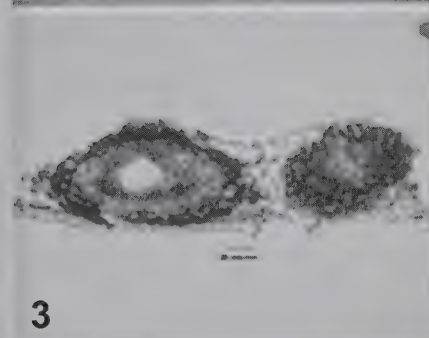
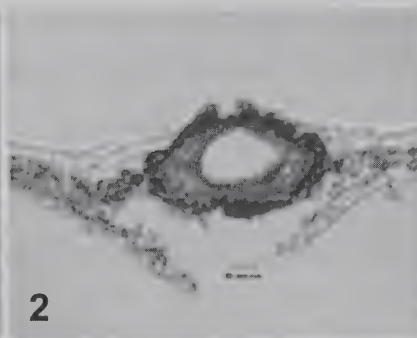
Pseudothecii foliicolis, globosis, ostiolatis, 60–112 μm diam, 60–135 μm altis; *ascis bitunicatis*, 8-sporis, 50–60 $\times$ 5.5–11 μm ; *ascosporis unicellularibus, oblongis vel longum ellipsoideis*, 11–15.7 $\times$ 3.9–5.3 μm .

Leaf spots up to 1.5–6.0 mm diam., rounded, outer region purple-brown, inner region grayish-white. Pseudothecia forming under subspherical, raised, solitary, as darkened dots in the leaf spots; in vertical section 60–112 μm diam., 60–135 μm high, globose with a central ostiole, 13–14 μm . Asci 50–60 $\times$ 5.5–11 μm , 8-spored, broadly fusoid, with a short stalk, bitunicate, broadly rounded above. Ascospores oblong to long ellipsoid, rounded at both ends, 11–15.7 $\times$ 3.9–5.3 μm , 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, Jiaoxi, on leaves of *Ficus septica* Burm. f., 6.VII.1909, Y. Fujikuro, HMAS 11689. **Paratype:** Taizhong, on leaves of *Ficus septica*, 28.VIII.1945, 9305, HMAS 05305.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia niesslii* (Kunze ex Rehm) Lindau on *Populus* from Europe is similar to *Guignardia fici-septicae* in size of ascospores (9–15 $\times$ 3.5–5 μm vs. 11–15.7 $\times$ 3.9–5.3 μm) but produces wider asci (40–60 $\times$ 10–12 μm vs. 50–60 $\times$ 5.5–11 μm) and much larger pseudothecia (150–200 μm vs. 60–112 μm diam.) (Arx & Müller 1954). Among species of *Guignardia* on *Ficus*, *G. fici-septicae* is similar to *G. fici* in size of leaf spots but differs in having longer ascospores (11–15.7 μm vs. 6–13 μm) and smaller pseudothecia (60–112 μm vs. 117–174 μm diam.).

Figs. 1–8. *Guignardia* spp. 1–4. *Guignardia fici*: 1. Ascomata on natural substrates, bar = 1 mm; 2. Structure of ascoma in section; 3. Structure of ascomata in section; 4. Asci with ascospores. 1, 4 from HMAS 11656; 2, 3 from HMAS 05351. 5–6. *Guignardia fici-septicae*: 5. Structure of ascomata in section (HMAS 11689); 6. Asci with ascospores (HMAS 05305). 7–8. *Guignardia linderiae* (HMAS 11690): 7. Structure of ascomata in section; 8. Asci with ascospores.



Guignardia linderæ Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.**

Figs. 7–8

MYCOBANK # MB 510680.

[*Guignardia linderæ* Sawada, Rep. Govt. Res. Inst. Formosa 86: 10, 1943. ICBN Art. 36.1, not validly published.]*Pseudotheciis foliicolis, globosis, ostiolatis, 71–99 µm diam, 70–94 µm altis; ascis bitunicatis, 8-sporis, 50–60 × 6–12 µm; ascosporis unicellularibus, oblongis vel longum ellipsoideis, 10–14 × 3.3–4 µm.*

Leaf spots up to 1.5–6 mm diam., rounded, outer region dark-brown, inner region grayish-yellow-brown. Pseudothecia forming under spherical, raised, darkened dots in the leaf spots, solitary; in vertical section 71–99 µm diam., 70–94 µm high, globose with a central ostiole. Peridium thin, composed of a few layers of brown pseudoparenchymatous angular cells 11–13 µm diam. Asci 50–60 × 6–12 µm, 8-spored, broadly cylindrical to clavate, with a short stalk, bitunicate, broadly rounded above. Ascospores 10–14 × 3.3–4 µm, oblong to long ellipsoid, rounded at both ends, 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Xinzhu, on leaves of *Lindera glauca* var. *kawakamii* Hayata, 16.XII.1919, E. Kurosawa, HMAS 11690.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia foeniculata* (Mont.) Arx & E. Müll. on *Umbelliferae* is similar to *Guignardia linderæ* in size of ascospores (10–16 × 3–5 µm vs. 10–14 × 3.3–4 µm) but produces much shorter asci (40–50 × 8–12 µm vs. 50–60 × 6–12 µm) and much larger pseudothecia (100–160 µm vs. 71–99 µm diam.) (Arx & Müller 1954).

Guignardia manihoticola Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.**

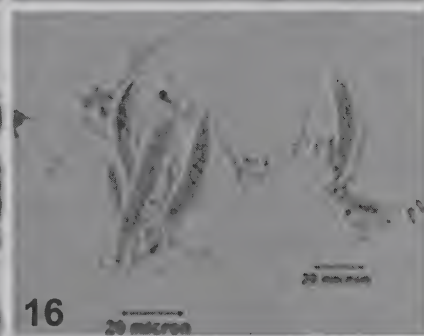
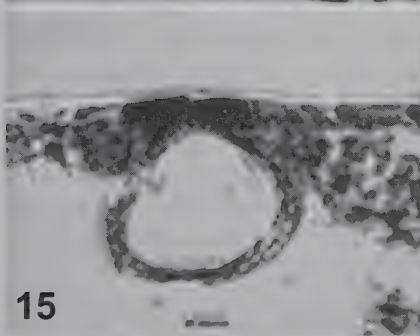
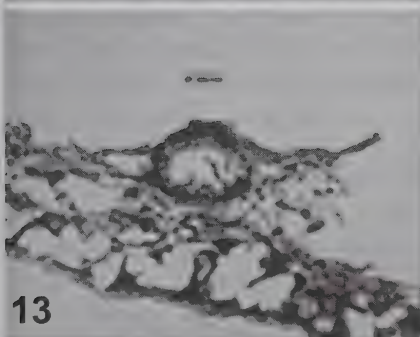
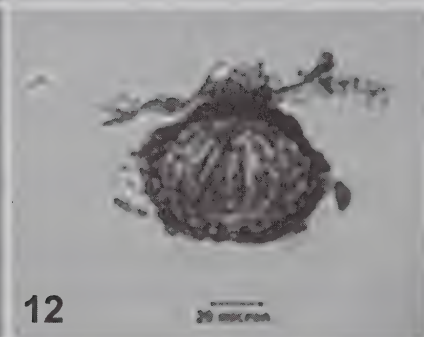
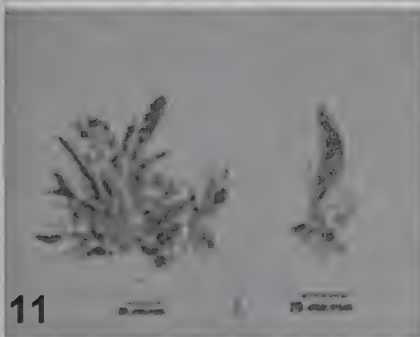
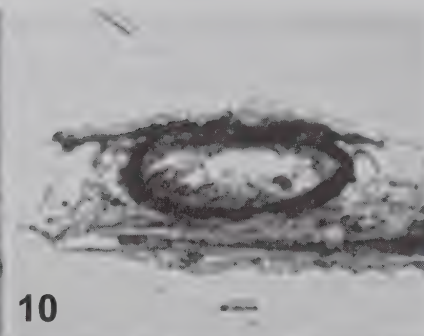
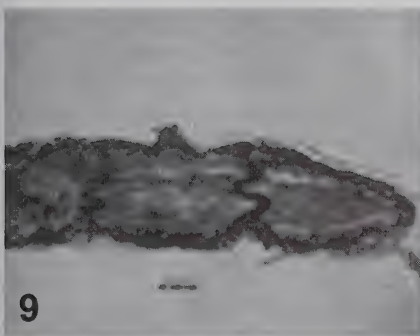
Figs. 9–11

MYCOBANK # MB 510678.

[*Guignardia manihoticola* Sawada, Spec. Publ. Coll. Agric., Nat. Taiwan Univ. 8: 59, 1959. ICBN Art. 36.1, not validly published.]*Pseudotheciis foliicolis, subglobosis vel subdeplanatis, ostiolatis, 75–216 µm diam, 62–76 µm altis; ascis bitunicatis, 8-sporis, 50–73 × 8–17.5 µm; ascosporis unicellularibus, fusioideis vel longum ellipsoideis, 13.8–20 × 4–6.6 µm.*

Leaf spots grayish-white, separated from the living tissue by a light brown and more or less raised border, studded with minute black perithecia in crowd or sparsely under epidermis. Pseudothecia dark black, solitary or gregarious, in

Figs. 9–16. *Guignardia* spp. 9–11. *Guignardia manihoticola* (HMAS 11695): 9, Structure of ascomata in section; 10, Structure of an ascoma in section; 11, Asci with ascospores. 12–14. *Guignardia polygoni-chinensis* (HMAS 11688): 12, 13, Structure of ascoma in section; 14, Asci with ascospores. 15–16. *Guignardia smilacicola* (HMAS 11692): 15, Structure of ascoma in section; 16, Asci with ascospores.



vertical section 75–216 μm diam., 62–76 μm high, subglobose to somewhat flattened, with an ostiole 23–26 μm across. Asci 50–73 $\times$ 8–17.5 μm , 8-spore in 2 rows, cylindrical, bitunicate, round at the apex, with a short-stalk, paraphyses lacking. Ascospores 13.8–20 $\times$ 4–6.6 μm , fusoid, oblong-ellipsoid, ends rounded, hyaline, unicellular, straight or curved, filled with granules. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Manihot utilissima* Pohl, 8.I.1909, Y. Fujikuro, HMAS 11695.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Among species of *Guignardia* on *Manihot*, the present fungus is similar to *Guignardia manihoti* Sacc. in asci but differs obviously in longer and multiguttulate instead of 1–2-guttulate ascospores (13.8–20 $\times$ 4–6.6 μm vs. 12–14 $\times$ 4–6 μm) (Sawada 1959).

Guignardia polygoni-chinensis Sawada, W.Y. Li & W.Y. Zhuang, sp. nov. Figs. 12–14
MYCOBANK # MB 510676.

[*Guignardia polygoni-chinensis* Sawada, J. Taihoku Soc. Agric. 7 (2): 124, 1943 ('1942'); as '*polygoni-chinense*'. ICBN Art. 36.1, not validly published.]

Pseudothecii foliicolis, subglobois, ostiolatis, 65–96 μm diam, 46–63 μm altis; ascis bitunicatis, 8-sporis, 35–47 $\times$ 8–14 μm ; ascosporis unicellularibus, fusoides, 12–18 $\times$ 3.5–5 μm .

Leaf spots up to 1–3 mm diam., rounded, outer region purple-brown, inner region necrotic and grayish-white to yellow-brown. Pseudothecia forming under spherical, raised, dark-brown dots in the leaf spots, solitary, in vertical section 65–96 μm diam., 46–63 μm high, semi-immersed, subglobose with a central ostiole, 13–18 μm diam. Asci 35–47 $\times$ 8–14 μm , 8-spored, clavate, with a short stalk, bitunicate, rounded at both ends, paraphyses lacking. Ascospores 12–18 $\times$ 3.5–5 μm , fusoid, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Polygonum chinense* L., 2.XI.1919, E. Kurosawa, HMAS 11688.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia haydenii* (Berk. & M.A. Curtis) Arx & E. Müll. on *Aster* and *Erigeron* is similar to *Guignardia polygoni-chinensis* in size of ascospores (12–18 $\times$ 3–5 μm vs. 12–18 $\times$ 3.5–5 μm) but possesses wider asci (30–45 $\times$ 12–18 μm vs. 35–47 $\times$ 8–14 μm) and much larger pseudothecia (100–180 μm vs. 65–96 μm diam.) (Arx & Müller 1954).

Guignardia smilacicola Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 15–16
 MYCOBANK # MB 510678.

[*Guignardia smilacicola* Sawada, Spec. Publ. Coll. Agric., Nat. Taiwan Univ. 8: 59, 1959.
 ICBN Art. 36.1, not validly published.]

Pseudothecii foliiculis, subglobosis, ostiolatis, 90–190 µm diam., 101–156 µm altis; ascis bitunicatis, 8-sporis, 41–65 × 6.5–10 µm; ascosporis unicellularibus, oblongis, 15.5–20 × 4.5–6 µm.

Leaf spots up to 0.5–2 mm diam., angular or subcircular, outer region dark-brown, inner region yellow-brown to brown, slightly depressed, scattered with several black dots; Pseudothecia epiphyllous, subepidermal, a little convex, in vertical section 90–190 µm diam., 101–156 µm high, immersed, subglobose, ostiole 20–26 µm wide, wall consisting of angular cells which are 15–20 µm large, pseudoparenchymatous; Asci 41–65 × 6.5–10 µm, 8-spored in 2 rows, cylindrical, short stipe, bitunicate, tip rounded, base obtuse. Ascospores 15.5–20 × 4.5–6 µm, oblong to fusoid, rounded at both ends, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Smilax elongato-umbellata* Hayata, 10.X.1920, K. Sawada, HMAS 11692.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia cocogena* (Cooke) Punith. on *Cocos* and *Archontophoenix* is similar to *Guignardia smilacicola* in size of ascospores (13–20 × 5–6.5 µm vs. 15.5–20 × 4.5–6 µm) but possesses clavate, much larger asci (60–100 × 10–12 µm vs. 41–65 × 6.5–10 µm) (Hyde 1995).

Acknowledgments

The authors would like to express their deep thanks to Prof. R. P. Korf and Dr. O. Eriksson for serving as pre-submission reviewers, nomenclatural insight, and valuable suggestions, Dr. T. Hosoya and Dr. Y. Z. Wang for providing useful references, Dr. G. R. Hu for specimen information, and Mr. J. Luo for helping with the plates. This project was supported by the National Natural Science Foundation of China (nos. 30499340, 30670055).

Literature cited

- Aa HA van der. 1973. Studies in *Phyllosticta* I. Stud. Mycol. 5: 1–110.
 Arx JA von, Müller E. 1954. Die Gattungen der amerosporen Pyrenomyceten. Beitr. Kryptog. Fl. Schweiz 11(1): 1–434.
 Barr ME. 1987. Prodomus to Class *Loculoascomycetes*. Published by the author, Amherst, MA. 168 pp.
 Barr ME. 1989. The genus *Dothidotthia* (*Botryosphaeriaceae*) in North America. Mycotaxon 34: 517–526.
 Ellis JB, Everhart BM. 1892. The North American *Pyrenomycetes*. Published by the authors,

- Newfield, New Jersey. 793 pp.
- Eriksson OE, Yue JZ. 1988. The *Pyrenomyces* of China, an annotated Checklist. University of Umea, Sweden. 88 pp.
- Greuter W, McNeill J, Barrie FR, Burdet HM, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Treharne P, Turand NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (St. Louis Code). Regnum Veg. 138. Koeltz Scientific Books, Königstein.
- Huang TZ. 1977. A new species of *Botryosphaeria*. Acta Microbiol. Sin. 17: 303-305.
- Hyde KD. 1995. Fungi from palms. XX. The genus *Guignardia*. Sydowia 47: 180-198.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. CABInternational, Wallingford. 655 pp.
- Lu BS, Hyde KD, Ho WH, Tsui KM, Taylor JE, Wong KM, Yanna, Zhou DQ. 2000. Checklist of Hong Kong fungi. Fungal Diversity Press, Hong Kong. 207 pp.
- Pennycook SR, Samuels GJ. 1985. *Botryosphaeria* and *Fusicoccum* species associated with ripe fruit rot of *Actinidia deliciosa* (kiwifruit) in New Zealand. Mycotaxon 24: 445-458.
- Sawada K. 1943a. Fungi found in Formosa (4). J. Taihoku Soc. Agric. 7(2): 108-128.
- Sawada K. 1943b. Materials of the Formosan fungi (50). J. Taiwan Soc. Nat. His. 33: 6-7.
- Sawada K. 1943c. Descriptive catalogue of Taiwan (Formosan) fungi, Part IX. Rep. Govt. Res. Inst. Formosa 86: 9-11.
- Sawada K. 1944. Descriptive catalogue of Taiwan (Formosan) fungi, Part X. Rep. Govt. Res. Inst. Formosa 87: 22-28.
- Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi, Part XI, Published Coll. Agric. Nat. Taiwan Univ. 268 pp.
- Shoemaker RA. 1964. Conidial states of some *Botryosphaeria* species on *Vitis* and *Quercus*. Can. J. Bot. 42: 1297-1301.
- Sivanesan A. 1984. The bitunicate ascomycetes and their anamorphs. Cramer, Vaduz. 701 pp.
- Slippers B, Crous PW, Denman S, Coutinho TA, Wingfield BD, Wingfield MJ. 2004. Combined multiple gene genealogies and phenotypic characters differentiate several species previously identified as *Botryosphaeria dothidea*. Mycologia 96: 83-101.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing, China. 1527 pp. (in Chinese).
- Teng SC. 1934. Notes on *Sphaeriales* from China. Sinensia 4: 353-433.
- Teng SC. 1963. Fungi of China. Science Press, Beijing, China. 808 pp. (in Chinese).
- Teng SC (Korf RP ed.). 1996. Fungi of China. Mycotaxon Ltd., Ithaca. 586 pp.
- Wang YZ, Wu SH, Zhou WN, Chang DZ, Chen KY, Chen SF, Chen CL, Tzeng SS, Liou JH, Hsieh WH, Hsieh HR, Chung CH, Chien CY (eds.). 1999. List of the fungi in Taiwan. Committee for Agriculture. Taipei. 289 pp. (in Chinese).

Did Mussat make new combinations in Sylloge Fungorum XV, 1901?

H.-J. SCHROERS^{1*}, G.J. SAMUELS² & W. GAMS^{3*}

*hans.schroers@kis.si & *gams@cbs.knaw.nl

¹Agricultural Institute of Slovenia

Hacquetova 17, 1000 Ljubljana, Slovenia

²U.S.D.A.-A.R.S., Systematic Botany and Mycology Laboratory

Rm. 304, B-011a, Beltsville, MD 20705, U.S.A.

³CBS Fungal Biodiversity Centre

Uppsalaalaan 8, 3584 CT Utrecht, The Netherlands

Abstract—Recently, two homonymous combinations, each based on a unique type and credited to different authorities, were used for the destructive mycoparasite *Clonostachys rosea*. The existence of the binomial *Clonostachys rosea* (Preuss) Mussat 1901 would render the more recently established *C. rosea* (Link : Fr.) Schroers et al. 1999 illegitimate. A textual analysis proves, however, that Mussat's combination *Clonostachys rosea* is invalid according to Article 34.1(a) and (c) of the International Code of Botanical Nomenclature. We know of no formally published instance where Preuss himself raised *Clonostachys araucaria* var. *rosea* Preuss to species level. Therefore, the name *Clonostachys rosea* Preuss, as it was listed by Mussat, cannot be regarded as valid either. Similarly, the binomials *Alternaria citri* (Penzig) Mussat, *Alternaria macrospora* (Sacc.) Mussat and *Clonostachys compacta* (Preuss) Mussat cannot be regarded as having been validly published by Mussat.

Introduction

Clonostachys rosea (Link : Fr.) Schroers et al. 1999 (anamorphic *Bionectria ochroleuca* (Schwein.) Schroers & Samuels 1997) is a frequently isolated soil fungus and destructive mycoparasite used in the biocontrol of fungal plant pathogens (Nobre et al. 2005 and many others). Recently it also was shown to be a parasite of insects (Toledo et al. 2006). The species is also well known as *Gliocladium roseum* Bainier (see, for example, Domsch et al. 1980) after Bainier (1907) introduced that name without referring to any older name. However, the species had been described much earlier by Link as *Penicillium roseum* (Link 1816), the epithet of which was adopted by Schroers et al. (1999) and Schroers (2001) as the basionym for the species in *Clonostachys*. Because the species epithets given by Link and Bainier were identical, this transfer avoided

the introduction of a new name; Bainier's epithet, based on a different type, was considered a later synonym (Schroers et al. 1999).

The epithet "*rosea*" had also been used by Preuss for what he regarded as a variety of *Clonostachys araucaria* Corda (Preuss 1853). This variety was considered a possible synonym of *C. rosea* by Schroers et al. (1999). Although Schroers et al. (1999) erroneously reported that no *Clonostachys* structure could be seen on its original material, reexamination of the material revealed morphologically characteristic structures (see below). Recently the epithet "*rosea*" of Preuss was adopted by Berg et al. (2005) and Renker et al. (2005) as if it had been validly combined as *Clonostachys rosea* (Preuss) Mussat 1901. The existence of this binomial would indeed render the binomial introduced by Schroers et al. (1999) illegitimate.

The above references and the continued listing in Index Fungorum of binomials supposedly proposed by Mussat such as *Clonostachys rosea* (Preuss) Mussat and *Alternaria citri* (Penz.) Mussat, by which former varieties would be raised to species rank, and younger, well-established binomials displaced, prompted the following analysis.

Analysis and discussion

Mussat (1901) entitled volume XV of Sylloge Fungorum "Synonymia generum, specierum, subspecierumque in vol. I–XIV descriptorum". He presented lists of fungal names in a two-column system and the two columns were connected by an equal sign. The names *Clonostachys compacta* Preuss and *C. rosea* Preuss were listed in the left-hand column and they were linked by the equal sign to the names of varieties of "*Clonostachys araucaria* Corda, var. IV, 165" (i.e., page 165 of volume IV of the Sylloge Fungorum) in the right-hand column, respectively "*Clonostachys araucaria* Corda var. *compacta* Preuss" and "*Clonostachys araucaria* Corda var. *rosea* Preuss". Without consideration of the background, the name in the left-hand column might be considered the accepted name and the name in the right hand column the synonym.

In the introduction to the volume Mussat (1901: vi) explained the motivation and nature of his compilations. He stated:

"Les synonymes qui se rencontrent le plus fréquemment dans les conditions susdites ont été relevés et vérifiés avec soin, puis disposés par ordre alphabétique en un index à deux colonnes, de façon à ce que, quelque soit le nom cherché, le lecteur voie immédiatement à sa suite celui qui a été adopté pour la même espèce dans le *Sylloge*, avec renvoi au volume où se trouve la description."

[The synonyms that are most frequently observed in the above described conditions have been identified and checked carefully, then ordered alphabetically in a 2 column index, in such a way that whatever the searched name, the reader immediately sees the

one that was adopted for the same species in the *Sylloge*, with a link to the volume where the description can be found.]

It is evident that the volume is structured in such a way that the left-hand column contains the synonyms, which are equated to names recognized in the *Sylloge Fungorum* (listed in the right-hand column). Therefore, it is the name in the right-hand column that Mussat recognized. His example of *Polystigma rubrum* DC (p. 131 and 454, right columns), which he equated to left-hand column entries of *Dothidea rubra* Fr. and *Xyloma rubrum* Pers., respectively, indicates that Mussat intended to address formally published synonymy. He may have, however, also included names from undefined descriptive works, collections (public or private herbaria, exsiccates etc.) of more or less ancient origin [“les ouvrages descriptifs, les collections (Herbiers publics ou privés, Exsiccata etc.) d’une origine plus ou moins ancienne” (Mussat 1901: v)] to equate these to names adopted in the *Sylloge Fungorum*. While it is obvious that Mussat listed numerous basionyms in the left-hand column, he may have mentioned also names encountered, for example, on specimen labels.

The entry on page 95 reads: “*Clonostachys rosea* Preuss = *Clonostachys araucaria* Corda, var. IV, 165”. Obviously, the latter name is the one recognized by Mussat. There is no reason to consider *Clonostachys rosea* Preuss as a newly introduced binomial accepted by Mussat.

Many other names listed in that volume by Mussat clearly illustrate how he formally annotated combining authors. For example, on the same page he placed the validly published name “*Coccotrichum brevius* B. & Br.” in the left-hand column and equated it with “*Botrytis brevior* Sacc. IV, 123”. Although Mussat clearly refers the epithet “*brevius*” to Berkeley & Broome, he does not refer to these authors in the right-hand column and only the combining author, Saccardo, is cited. Had Mussat ever intended to create a valid new combination, he would have written “*Clonostachys rosea* Mussat”, placing this name in the right-hand column and referring to *Clonostachys araucaria* Corda var. *rosea* Preuss as its synonym in the left-hand column.

We conclude that Mussat (1901) did not make any new combinations in this volume. According to Article 34.1(a) of the International Code of Botanical Nomenclature (McNeill et al. 2006), formal acceptance by the author in the original publication is a prerequisite for valid publication of any combination. Therefore, although the binomial “*Clonostachys rosea*” is effectively published, the combination that would have to be ascribed to Mussat [Art. 34.1(a), (c)] is invalid. Because we are unaware of a combination published by Preuss himself [such as “*Clonostachys rosea* Preuss” or “*Clonostachys rosea* (Preuss) Preuss”], we also conclude that the name “*Clonostachys rosea* Preuss”, as listed in the left-hand column of Mussat (1901: 95), cannot be regarded as valid either. Similarly,

the binomials *Alternaria citri*, *A. macrospora* and *Clonostachys compacta*, listed by Mussat in the left-hand column of this volume (pages 43 and 95), cannot be regarded as validly published.

Taxonomy

Clonostachys rosea (Link : Fr.) Schroers, Samuels, Seifert & W. Gams, Mycologia 91: 369. 1999.

= *Penicillium roseum* Link : Fr., Ges. Naturf. Freunde Berlin Mag. 7: 37 (1816); sanctioned by Fries, Syst. Mycol. 3: 409 (1832).

= *Clonostachys araucaria* var. *rosea* Preuss, Linnaea 25: 727 (1853) (B!).

= *Gliocladium roseum* Bainier, Bull. Soc. Mycol. France 23: 111 (1907).

Notes—For a full list of synonyms see Schroers et al. (1999) and Schroers (2001). Two specimens of variety *rosea* (herb. Preuss, file 327), nr. 527 (on an immature fruit) and nr. 529 (on a twig) were studied. Off-white or yellowish white sporodochia or aggregates of densely packed, but individually recognizable, penicillate conidiophores are the predominating fungal structures on both specimens. The penicilli of individual conidiophores are adpressed giving rise to narrow columns of imbricate conidia. On many aggregates and sporodochia, the columns appeared collapsed into a dome-shaped conidial mass. The conidia are ellipsoidal, slightly curved and have a slightly laterally displaced hilum. They measure (4.4–)5.4–5.7–6.2(–7.6) × (2.1–)2.6–2.6–2.7(–3.2) µm. This is *Clonostachys rosea* as described by Schroers et al. (1999). We here designate specimen nr. 529 (B) as the lectotype of *C. araucaria* var. *rosea* Preuss and specimen nr. 527 (B) as paratype.

Acknowledgements

We thank John McNeill (Royal Botanic Garden, Edinburgh, U.K.) and Emory G. Simmons (Wabash College, Crawfordsville, U.S.A.) for valuable comments on the discussed matter. We thank Paul Kirk (CABI Bioscience, Egham, U.K.) for reviewing the manuscript and explaining that the binomial "*Clonostachys rosea*" has effectively been published and Shaun Pennycook (Landcare Research, Auckland, NZ) for the suggestion to elucidate Mussat's intentions. Vincent Robert (CBS Fungal Biodiversity Centre, Utrecht, NL) kindly provided an explicit translation of the cited part of Mussat's text. We are also indebted to Burghard Hein, curator at the herbarium of the Botanical Garden and Botanical Museum Berlin-Dahlem (B), for the loan of specimens.

Literature cited

- Bainier G. 1907. *Gliocladium roseum* sp. nov. et *Cephalosporium acremonium* (Corda). Bulletin Trimestriel de la Société Mycologique de France 23: 111–114.
- Berg G, Zachow C, Lottmann J, Götz M, Costa R, Smalla K. 2005. Impact of plant species and site on rhizosphere-associated fungi antagonistic to *Verticillium dahliae* Kleb. Applied and Environmental Microbiology 71: 4203–4213.

- Domsch KH, Gams W, Anderson T-H. 1980. Compendium of soil fungi. Academic Press London. Reprint 1993, IHW-Verlag Eching. [2nd Edn. 2007. IHW-Verlag and Centraalbureau voor Schimmelcultures, Utrecht.]
- Link HF. 1816. Observationes in ordines plantarum naturales. 2. Gesellschaft der Naturforschenden Freunde Berlin, Magazin der Neuesten Entdeckungen aus der Gesamnten Naturkunde 7: 25–45.
- McNeill J, Barry FR et al., eds. 2006. International Code of Botanical Nomenclature (Vienna Code), adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Gantner Verlag, Ruggell. Regnum Vegetabile 146.
- Mussat E. 1901. Synonymia generum, specierum, subspecierumque in vol. I–XIV descriptorum. Sylloge Fungorum omnium hucusque cognitorum digessit P.A. Saccardo 15: 1–455.
- Nobre SAM, Maffia LA, Mizubuti ESG, Cota LV, Dias APS. 2005. Selection of *Clonostachys rosea* isolates from Brazilian ecosystems effective in controlling *Botrytis cinerea*. Biological Control 34: 132–143.
- Preuss GT. 1853. Übersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. Linnaea 25: 723–742.
- Renker C, Otto P, Scheider K, Zimdars B, Maraun M, Buscot F. 2005. Oribatid mites as potential vectors for soil microfungi: Study of mite-associated fungal species. Microbial Ecology 50: 518–528.
- Schroers H-J. 2001. A monograph of *Bionectria* (Ascomycota, Hypocreales, Bionectriaceae) and its *Clonostachys* anamorphs. Studies in Mycology 46: 1–214.
- Schroers H-J, Samuels GJ, Seifert KA, Gams W. 1999. Classification of the mycoparasite *Gliocladium roseum* in *Clonostachys* as *C. rosea*, its relationship to *Bionectria ochroleuca*, and notes on other *Gliocladium*-like fungi. Mycologia 91: 365–385.
- Toledo AV, Virla E, Humber RA, Paradell SL, Lopez Lastra CC. 2006. First record of *Clonostachys rosea* (Ascomycota: Hypocreales) as an entomopathogenic fungus of *Oncometopia tucumana* and *Sonesimia grossa* (Hemiptera: Cicadellidae) in Argentina. Journal of Invertebrate Pathology 92: 7–10.

A new species of *Conidiobolus* from Great Smoky Mountains National Park

BO HUANG,^{1,2} RICHARD A. HUMBER,³ KATHIE T. HODGE²

¹ Anhui Provincial Key Laboratory for Microbial Pest Control,
Anhui Agricultural University, Hefei 230036, China

²Department of Plant Pathology, Cornell University, Ithaca, NY 14853, USA

³USDA-ARS Plant Protection Research Unit, Plant, Soil & Nutrition Laboratory, Tower
Road, Ithaca, NY 14853, USA

Abstract—*Conidiobolus margaritatus* sp. nov. is described from leaf litter in Great Smoky Mountains National Park, USA. Among the thirty accepted species of *Conidiobolus*, *C. margaritatus* exhibits the slowest growth at room temperature, a lichenoid compact mycelium on standard media, and forms unique chains of nondischarged repetitional conidia on water agar. Two species, *C. cercopidis* and *C. pseudapiculatus*, are transferred to *Batkoa* based upon molecular and morphological evidence.

Key words—Ancylistaceae, Entomophthorales, taxonomy, new combinations

Species of *Conidiobolus* Bref., most notably the ubiquitous *C. coronatus*, are isolated from decaying leaf litter, dung, and the fruiting bodies of other fungi; a few are opportunistic human pathogens or arthropod pathogens.

Little attention was paid to *Conidiobolus* for many years, until the important contributions of Charles Drechsler, who described 26 new American *Conidiobolus* species in 1950s and 60s. His detailed drawings illustrate his species, but unfortunately few useful type specimens exist. Many of Drechsler's original cultures are held by the American Type Culture Collections and provide essential complements to Drechsler's drawings. In a series of papers in the 1960s, Srinivasan and Thirumalachar described 13 new Indian species and varieties, suggesting some degree of endemism in the distribution of *Conidiobolus* species, and they reduced to synonymy eight more species. The most recent taxonomic synthesis of *Conidiobolus* is that of King (1976a, b, 1977), who studied the genus in detail using numerical taxonomy based on morphological, physiological and developmental features. King (1977) accepted 27 distinct species; his findings have been widely accepted.

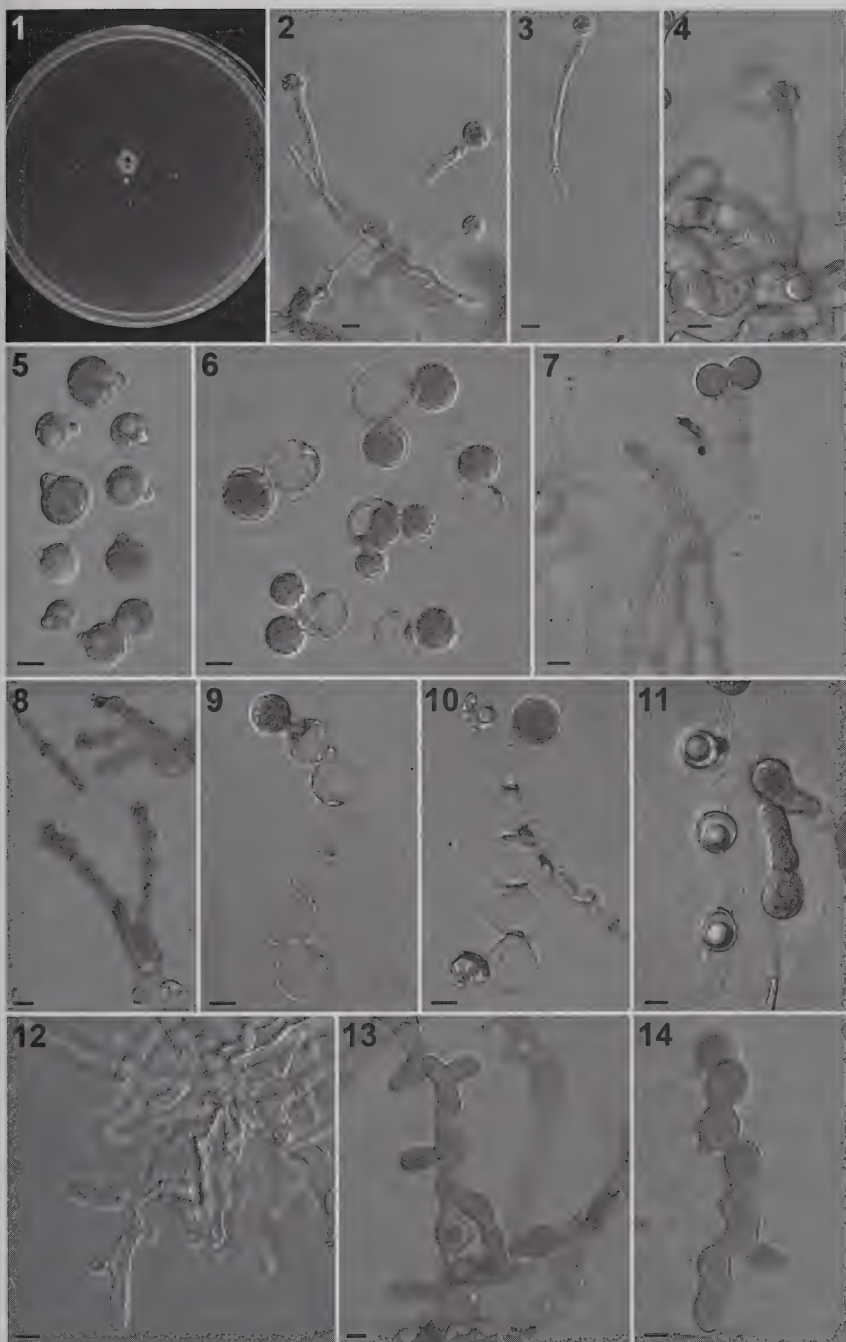
Since King's revisions, six additional species have been described. Both *C. pseudapiculatus* and *C. cercopidis* have nuclei containing readily stainable condensed heterochromatin during interphase, form rhizoids with flattened holdfasts, and also show a marked apical constriction of the conidiogenous cell below the conidium. These features are atypical of the genus *Conidiobolus* (*Ancylistaceae*) but are characteristic of species of *Batkoa* Humber (Humber 1989; *Entomophthoraceae*). Molecular data (not shown) confirm that *C. pseudapiculatus* should be treated as a species of *Batkoa* (we lack data for *C. cercopidis*); both species are transferred to *Batkoa* below. *Conidiobolus chlapowskii* Bałazy et al., a pathogen of mites, *Conidiobolus gustafssonii* Bałazy; and *Conidiobolus iuxtagenitus* S.D. Waters & Callaghan appear to be correctly placed in *Conidiobolus*. Molecular data and corresponding morphological data have led to the proposal of Huang et al. (in prep.) that *Conidiobolus antarcticus* S. Tosi et al. should be treated as a later synonym of *C. osmodes* Drechsler. In all, we consider the genus *Conidiobolus* to include 30 species.

Methods and results

We assayed leaf litter for *Conidiobolus* species during an October 2006 expedition to Great Smoky Mountains National Park in the southeastern US. Our results, gathered over four days, provide only a preliminary look at *Conidiobolus* diversity in the Park.

We used a canopy plating approach similar to those of King (1976) and Drechsler (1952) that exploits the forcible discharge of *Conidiobolus* spores. Partly decomposed leaves and detritus from the interface between the O and A soil horizons were collected and transported to the lab in plastic bags. Within eight hours, the samples were processed by snipping organic fragments finely using scissors. A small amount of snipped material was embedded in molten 20% water agar in the lid of a 10 cm Petri dish. The bottom of the dish, containing potato dextrose agar (PDA: Difco), was inverted over the detritus, and the dishes were sealed with Parafilm. The dishes were incubated at room temperature, and monitored over about five days using a dissecting microscope for the development of typical compact, glassy colonies of entomophthoralean fungi. As they were detected on the PDA canopy, they were transferred to new

Figs. 1–14. *Conidiobolus margaritatus*. 1. Colony on PDA after 4 days at 20°C. 2, 3. Long primary conidiophores. 4. Short primary conidiophore. 5. Primary conidia. 6. Secondary conidia produced singly or in pairs from the primary conidia. 7. Primary conidiophore producing two primary conidia. 8. Primary conidia remaining attached to the conidiophore, and forming a chain of successively repetitional conidia. 9–10. Necklace-like chains of undischarged repetitional conidia forming from primary conidia. 11. Zygosporangia. 12. Young mycelium. 13–14. Old mycelium showing lobed development.



PDA plates for morphological study. Duplicate samples from seven different sites within the Park were screened.

Five species of the genus *Conidiobolus* were isolated and transferred to potato dextrose agar (PDA). These methods can also capture species of *Basidiobolus*, but none were detected during the sampling period. The most frequently detected *Conidiobolus* species was *C. coronatus* (Costantin) A. Batko, which was found in 46% of litter samples. We also isolated single instances of *C. adiaeretus* Drechsler; *C. rhysosporus* Drechsler; an unidentified *Conidiobolus* species that will be the subject of further study; and one *Conidiobolus* species that we judge to represent a new species. The latter is morphologically distinct from other species of *Conidiobolus*, and is described as new below.

Taxonomy

Conidiobolus margaritatus B. Huang, Humber & K. T. Hodge, *sp. nov.* (Figs 1–14)
MYCOBANK MB 510685.

Coloniae in agaro "PDA" tarde crescentia, diametris 2.5–4.0 mm post 7 dies ad 25°C, subalba, compacta, opaca. Hyphae assimilativae hyalinae, 0–5-plo ramosae, saepe contortae, 12.5–17.5 µm latae, cellulas apicales 110–180 µm longis; subapicale ubi maturae inflatae, lichenoides, contortae, cellulis inflatae globosae ellipsoideae 30–40 µm in latitudine formantes. Conidiophora hyalina, 30–450 x 8.9–15.5 µm, simplicia aut interdum bifurcata, omni ramo conidio globoso apicale singulariter. Conidia primaria hyalina, 21.2–37.5 x 15–32.7 µm, papilla 5.0–10.0 in longitudine 7.5–15.0 µm in latitudinem, expulsa vehementer eversi papillae ope autem saepe catenis margaritis inexpulsis simulantibus formantia. Conidia secundaria simplicia dupliciave, 21.2–37.5 x 15–32.7 µm, expulsa vehementer autem catenis inexpulsis conidia primaria simulantia. Sporae perdurantes zygosporae laeves, subglobosae, 27.5–42.5 µm, parietis bistratis 2.0–2.8 µm crassitie, ex cellulis contiguis formantes, globulo oleoso magnopere impletae ubi maturis.

Holotype—CUP 67624. USA: TN: Great Smoky Mountains National Park. October 7, 2006. Decayed leaf litter along West Prong Trail near Great Smoky Mountains Institute at Tremont (17256344E, 3947185N, 341m). Isolated from leaf litter by Bo Huang (3-litter-1). The ex type culture, ARSEF 8314 deposited in the USDA-ARS Collection of Entomopathogenic Fungal Cultures (Ithaca, NY).

Etymology—From the Latin, *margaritatus* (beaded; pearls). The species is named for the frequently beaded appearance of both conidiophores and secondary conidia.

Colonies on PDA extremely slow growing, attaining a diameter of 2.5 to 4.0 mm within 7 days at 20°C; off-white, compact and opaque. Assimilative hyphae colorless, moderately branched (with 0–5 branches), usually somewhat crooked; 12.5–17.5 µm wide; at the margin of an expanding mycelium often terminating in a cell 110–180 µm, later in positions behind the forefront usually undergoing conversion into swollen segments, forming a compact lichenoid mass of crooked distended hyphae intermixed with inflated ellipsoid and sphaeroid cells, 30–40 µm wide. **Conidiophores** colorless, commonly

unbranched and producing a single globose conidium, quite variable in length, 30–430 x 8.9–15.5 μm , but in some instances bifurcated and bearing 2 globose conidia simultaneously. **Conidia** forcibly discharged, but in many instances a primary conidium stopping growth while on the conidiophore and forming another conidium on the top of primary conidia, with this procedure repeating several times to form a chain of undischarged conidia. Globose primary conidia forcibly discharged, colorless, 21.8–40.8 μm wide, 26.8–45.0 μm long including a basal papilla 5.0–10.0 μm high and 7.5–15.0 μm wide. After discharge onto water agar, primary conidia giving rise to 1–2 secondary conidia, 21.2–37.5 x 15–32.7 μm , or forming a chain of up to seven undischarged repetitional conidia. **Zygospor**es smooth, subglobose, 27.5–42.5 μm , with a thick double-layered wall (2.0–2.8 μm), formed between adjacent conjugating cells of a hyphal body, with a relatively large lipid globule.

Conidiobolus margaritatus is distinct from other *Conidiobolus* species we have studied in culture in that it grows unusually slowly on PDA, and in its colonies that are compact, lichenoid mycelial masses. While all *Conidiobolus* species form secondary conidia, *C. margaritatus* produces several unusual repetitional structures in culture: 1) necklace-like chains of undischarged repetitional conidia are frequently formed from primary conidia after forcible discharge onto water agar (Fig. 9–10); 2) two secondary conidia can arise from a single primary conidium (Fig. 6); and 3) primary conidia that remain attached to the conidiophore can produce a chain of successively repetitional conidia (Fig. 8).

As noted above, nuclear and conidiophore characteristics suggest that *Conidiobolus pseudapiculatus* and *C. cercopidis* are best reassigned to the genus *Batkoa* (*Entomophthoraceae*). We propose the following new combinations:

Batkoa cercopidis (S. Keller) B. Huang, Humber & K.T. Hodge, **comb. nov.**

MYCOBANK MB 510686

Basionym: *Conidiobolus cercopidis* S. Keller, 1991, Sydowia 43: 117; validated by S. Keller, 1994, Sydowia 46: 41.

Batkoa pseudapiculata (S. Keller) B. Huang, Humber & K.T. Hodge, **comb. nov.**

MYCOBANK MB 510687

Basionym: *Conidiobolus pseudapiculatus* S. Keller, 1991, Sydowia 43: 118; validated by S. Keller, 1994, Sydowia 46: 42.

Discussion

It its compact vegetative hyphae, *Conidiobolus margaritatus* resembles *C. lobatus* M.C. Sriniv. & Thirum., *C. lichenicola* M.C. Sriniv. & Thirum., and *C. lachnodes* Drechsler. The new species differs from *C. lichenicola* mainly in its subglobose primary conidia, its slow growth, and the larger size of its

zygospores (Srinivasan & Thirumalachar 1968b). *Conidiobolus margaritatus* is distinguished from *C. lobatus* mainly by its larger primary conidia, its lack of passively detached elongate conidia, and in bearing zygospores (Srinivasan & Thirumalachar 1968a). *C. margaritatus* differs from *C. lachnodes* in the size of primary conidia and zygospores (Drechsler 1955). No other species have been reported to routinely form non-discharged repetitional chains of conidia akin to those we describe here, although Callaghan (pers. comm.) reports that similar structures are occasionally seen in other *Conidiobolus* species subjected to drying conditions.

Species of *Conidiobolus* are generally poorly known, and many are known from only one or a few collections. Entomophthoralean fungi are difficult to preserve as herbarium specimens, so type material is often lacking or uninformative. We have described *C. margaritatus* based on what we consider to be a robust set of unique characters, but further study is needed to clarify the concepts of many *Conidiobolus* species, to detect phylogenetically informative characters, and to elucidate evolutionary relationships. Our preliminary morphological and molecular studies suggest that *Conidiobolus* has been keeping many secrets.

Acknowledgments

We are grateful to Drs. R. P. Korf and A. Callaghan for reviewing the manuscript. Collecting in the Great Smokies was supported by a grant from Discover Life in America to Kathie T. Hodge. B. Huang is grateful for grants from the National Natural Science Foundation of China (30300004), and NCET(05-0560).

Literature cited

- Bałazy S. 1993. *Entomophthorales: Flora of Poland (Flora Polska), Fungi (Mycota)*, v. 24. Kraków, Poland, Polish Academy of Science, W. Szafer Inst. Botany.
- Drechsler C. 1952. Widespread distribution of *Delacroixia coronata* and other saprophytic *Entomophthoraceae* in plant detritus. *Science* 115: 575–576.
- Drechsler C. 1955. Three new species of *Conidiobolus* isolated from decaying plant detritus. *Am J Bot* 42:437–443.
- Huang B, Humber RA, Hodge KT. In preparation. *Conidiobolus antarcticus*, a synonym of *Conidiobolus osmodes*. [Mycotaxon].
- Humber RA. 1989. Synopsis of a revised classification for the *Entomophthorales* (Zygomycotina). *Mycotaxon* 34: 441–460.
- Keller S. 1991. Arthropod-pathogenic *Entomophthorales* of Switzerland. II. *Erynia*, *Eryniopsis*, *Neozygites*, *Zoophthora* and *Tarichium*. *Sydowia* 43: 39–122.
- Keller S. 1994. Validation of the description of some species of *Entomophthorales* (Zygomycetes). *Sydowia* 46: 41–43.
- King DS. 1976a. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. I. Biology and cluster analysis. *Can. J. Bot.* 54: 45–65.
- King DS. 1976b. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. II. Taxonomic considerations. *Can. J. Bot.* 54: 1285–1296.

- King DS. 1977. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. III. Descriptions of recognized species. *Can. J. Bot.* 55: 718–729.
- Srinivasan, MC, and Thirumalachar, MJ. 1967. Evaluation of taxonomic characters in the genus *Conidiobolus* with a key to known species. *Mycologia* 59:698–713.
- Srinivasan MC, Thirumalachar MJ. 1968a. Two new species of *Conidiobolus* from India. *J. Elisha Mitchell Sci. Soc.* 84: 211–212.
- Srinivasan MC, Thirumalachar MJ. 1968b. Studies on species of *Conidiobolus* from India. V. *Mycopathol. Mycol. Appl.* 36: 341–346.

Typification of *Umbilicaria cinereorufescens*

GEIR HESTMARK

geir.hestmark@bio.uio.no

Department of Biology, University of Oslo

Pb. 1066 Blindern, N-0316 Oslo, Norway,

Abstract — The typification of the alpine lichen-forming fungus *Umbilicaria cinereorufescens* (Schaer.) Frey is discussed. A collection from the Herbar Lichénologique Schaerer (at G) is designated as lectotype.

Key words — nomenclature, *Umbilicariaceae*

Introduction

Since the recognition of *Umbilicaria cinereorufescens* as a distinct species by Eduard Frey (1931), this alpine lichen has been shown to have a worldwide distribution (Llano 1950, Poelt 1977, Krog & Swinscow 1986, Wei & Jiang 1993, Hestmark 1997). A clear typification of the species has, however, not been made, and this is a desideratum for taxonomic work on the genus *Umbilicaria*.

Umbilicaria cinereorufescens typically occurs on large siliceous, often wind-swept boulders in the lower alpine zone, usually at sites above the snow in winter. The thallus is coriaceous, mono- or polyphyllous, often with deep incisions, up to 7 cm in diameter; the upper surface light or medium grey to brown, smooth, sometimes undulating around center; the lower side is black, trabeculate around umbilicus, covered with numerous short, peglike or more irregular coralloid, black rhizinomorphs with thalloconidia; the medulla is white. Apothecia are rare, adnate, black, gyrose; asci: clavate; ascospores: 8–15 x 4–9 µm. The thalloconidia are dark brown to black, 6–10- to 30–40-cellular, 9–25–64 x 9–18–48 µm, gross outline spherical to more elongated or irregular, seceded from the tips of the rhizinomorphs (Hestmark 1990). Spot tests of medulla PD–, K–, C+ red, KC+ red. Secondary metabolites include gyrophoric acid, lecanoric acid and crustinic acid (Posner et al. 1992). The photobiont is unicellular green algae, probably *Trebouxia* sp.

Nomenclature

The Swiss clergyman and lichenologist Ludwig Emanuel Schaerer (1785–1853) treated the genus *Umbilicaria* in several works and made many valuable

observations on the morphology and reproductive structures of these lichens. However, with regard to the delimitation of *Umbilicaria* species, their variation and nomenclature, he appears to have been very confused, even by species previously well described, delimited and depicted by Linnaeus, Hoffmann and Acharius.

Following an excursion to the Grimsel area in the Swiss Alps in 1816, Schaerer presented a first synopsis in 1817 (Schaerer 1817). Here our species was probably referred to the taxon '*Gyrophora depressa* b. *G. spadochroa* D. vellea' characterized as 'thallo supra ex glauco cinereo-rufescente' (Schaerer 1817: 6). The names '*depressa*' and '*spadochroa*' had previously been used by Acharius and Hoffman for varieties. The name '*vellea*' derives from Linnaeus' '*Lichen velleus*' (1753: 1150), today *Umbilicaria vellea* (L.) Hoffm. Schaerer lists Acharius' '*G. vellea*' as synonymous. The descriptive term 'cinereo-rufescente' for the upper surface colour means 'ash grey becoming red'.

In the monograph *Umbilicariae Helveticae*, accompanied by four beautiful hand-coloured plates with a total of 59 figures, Schaerer recognized only six species in the genus *Umbilicaria*, each with a lot of variation (Schaerer 1823). The taxon '*Umbilicaria depressa*' he first divided into the two varieties '*hirsuta*' and '*spadochroa*', and these varieties into respectively five and seven forms identified by letters (A to E, and A to G) (Schaerer 1823: 93-99). And even for each of these lettered forms he in some cases presented several specimens and figures of the plates, so that plate Tab. X was devoted exclusively to the var. *hirsuta* in 21 figures, and the plate Tab. XI to the var. *spadochroa* with 17 figures. In Tab XI depicting forms of var. *spadochroa*, the form E, characterized by 'Thallo sicco supra ex glauco cinereo-rufescente' (Schaerer 1823: 95 & 99) is presented by three figures: Fig. 8, 9, and 10, all, according to the text, depicting thalli from Grimsel.

In 1823 Schaerer also started to issue the exsiccate *Lichenes helvetici exciccati* (1823-1852) that eventually ran into 650 numbers. To this he issued the text *Lichenum helveticorum spicilegium* (1823-1842), which in its 12th and final section had only reached to describe the first 450 of the specimens issued in the exsiccate. In 1826 he issued Nos. 100-150 of the exsiccate (fasc. 5 & 6) (Schaerer 1826a), and in the same year he published the description of these specimens where he states that No. 142 corresponds to the form 'E. Sicco supra ex glauco cinereo-rufescens' figured in his *Umbilicariae Helveticae* (1823) Tab. XI, fig. 8, 9 and 10 (Schaerer 1826b: 83).

When Schaerer published his *Enumeratio critica lichenum europaeorum* (Schaerer 1850), he had exchanged his own species name '*U. depressa*' with Hoffmann's *Umbilicaria vellea*. Under the latter taxon he now included the different varieties and forms previously listed for '*U. depressa*', now with three varieties: '*hirsuta*', '*depressa*' and '*spadochroa*' also distinguished by Greek

letters α , β , γ . This shows that Schaerer was still very confused about several species. *Umbilicaria vellea*, *U. hirsuta* and *U. spadochroa* were by 1850 by many lichenologists recognized as well delimited, separate species (as they remain today). (The spellings '*spadochroa*' and '*spodochroa*' were both used in the 19th century literature). Schaerer's variety ' γ . *spadochroa*' was divided into seven forms distinguished by small letters and a name, and here we find 'e. *cinereorufescens* Schær.; thallo sicco supra ex glauco cinereo-rufescente Spic. 83. E. 362. Exs. 142. Schær. l.c. t. 11. f. 8, 9, 10. Umb. *spadochroa* DC! Moug. & Nestl.! exs. 540. Gyr. *vellea* Ach! Lich. *velleus* Ehrh! phytoph. n. 80. – Apud nos satis vulgaris.' (Schaerer 1850: 25).

Thus the basionym for *Umbilicaria cinereorufescens* is: *Umbilicaria vellea* γ . *spadochroa* e. *cinereo-rufescens* Schaer., Enum. crit. lich. eur. 1850: 25. The specific epithet '*cinereorufescens*' had previously been used in other genera, among them by Acharius for an *Urceoloria* species. Schaerer's claim that his taxon is identical to taxa described or exsiccated by several others, is only partly correct but need not concern us here. More relevant is his reference to his own exsiccate No. 142 (Schaerer 1826a) and to the figures 8, 9, and 10 from Tab XI from his monograph (Schaerer 1823).

Schaerer's confused *Umbilicaria* taxonomy was largely ignored by other lichenologists in the decades after the publication of his Enumeratio. When Eduard Frey in the 1920s commenced work with a complete revision the European species of *Umbilicaria* for Rabenhorst's cryptogam flora he could not, however, ignore Schaerer's work. Frey made substantial collections in the Alps, including the Grimsel where he collected many thalli of the species he would name *U. cinereorufescens*. He also found this species on Dovre in Norway. With regard to the name of this taxon he was, however, initially led astray by Arnold (1878), who had named this '*U. spadochroa* f. *mammulata*' (Frey 1929: 241–244), a name originally based on the American species '*Gyrophora mammulata*' described by Acharius (now *Umbilicaria mammulata*). When Frey sent specimens of this to the Finnish botanists Linkola and Häyren for comparison with the Acharius originals in Herb. Acharius (in H), they both ascertained that it was not identical to *U. mammulata* (Frey 1931: 109–110). Frey then found recourse to Schaerer's *Umbilicaria vellea* γ . *spadochroa* e. *cinereo-rufescens*, establishing the species *Umbilicaria cinereorufescens* mainly because what he calls the original specimen (das Original exemplar), to fig. 10 on Tab. XI in Schaerer (1823) contain typical specimens of this species.

The specimens used by Schaerer for the illustrations in Schaerer (1823) Tab. XI, figs. 8, 9, and 10 are extant and can be identified in Schaerer's herbarium, which passed through the Herbarium Boissier and is now in G. They are all in folders marked with Schaerer exsiccate No. 142. The specimens depicted as fig. 8 and fig. 9 are now in two separate small envelopes in the bigger modern

brown envelope labelled (in pin-code) G00053125 (G) and 20050103/2 in pencil. On the one small envelope is handwritten in ink 'Specimen depictum t. XI. F. 8. Grimsel 8b 1816,' on the other 'Specimen depictum tab. XI. F. 9. Grimsel 8b 1816.' In addition this collection contains a card with five specimens glued onto it. Frey, who examined this collection (cf. Frey 1929: 248, and Frey 1931: 110), states correctly that the specimen for fig. 8 is *U. vellea*. He states the same for the specimen for fig. 9, which however, is *U. cinereorufescens*. The specimens glued on the plate are *U. vellea*. Thus the exsiccate No. 142 as well as the illustrations in Schaerer (1823) Tab. XI, fig. 8, 9 are a mixture of *U. vellea* and *U. cinereorufescens*. The exemplar of Schaerer's exsiccate in O exhibits the same mixture. *Umbilicaria cinereorufescens* is probably closely related to *U. vellea*. However, the latter species is easy to distinguish by having thin, white or ivory coloured, comparatively long rhizinomorphs in addition to the shorter, peglike, black, thalloconidiogeneous ones.

The collection that Schaerer (1823) evidently used for Tab. XI, fig. 10 is in a 'modern' brown envelope in G, marked Herbarium Genavense (G) G00053127 (pin code number), and also labelled in pencil 20050103/4. Within this envelope is a smaller original envelope from Schaerer's herbarium. On this smaller envelope is handwritten in ink 'Specimen depictum tab XI. F. 10. Grimsel Specim. fertil.' On this envelope Frey has glued a small piece of paper with the inscription 'G. mammulata Ach. Em. Frey det. 1929 Ed. Frey'. Although the collection has not up to now in any way been marked as a type, or more specifically as type of *U. cinereorufescens*, this is clearly Schaerer's 'original specimen' referred to by Frey (1931: 110) for Frey's *Umbilicaria cinereorufescens*, and accordingly should be considered the type collection for this species.

Frey's use of the term *Originalexemplar* raises the question whether he in fact *did* select a type for *U. cinereorufescens*, and made a valid typification. Several authors (e.g. Llano 1950: 183, Wei & Jiang 1993: 197), who explicitly state that they have *not* seen the type, state the type of *U. cinereorufescens* to be in Schaerer's Herbarium in Institute of Systematic Botany, University of Geneva, without any further specification of collection number, collector, place of collection, year of collection etc. Other authors (e.g. Poelt 1977: 417, Krog & Swinscow 1986: 81) do not cite a type for this particular species although they *do* for many other *Umbilicaria* species, thus indicating that the question regarding the typification of *U. cinereorufescens* has not been sufficiently investigated and unambiguously resolved. Frey did not use the term 'type' or 'typus', neither did he in any way mark the collection now in G00053127 to indicate it as what we today would call a type. Neither did he write the term 'Originalexemplar' anywhere on this collection. On the other hand it seems probable that when Frey in his lichenological works used the term 'Originalexemplar', he sometimes meant the same or nearly the same that we today mean by a type. But for instance

in Frey (1929: 243) he clearly uses the term differently, namely to denote the lichen thallus that was the 'original' for a particular *illustration*. Is G00053127 then to be identified as the holotype or a lectotype? Because of the ambiguity of Frey's use of 'Originalexemplar' I suggest that a lectotypification is appropriate.

There are several thalli in the type collection G00053127: two unattached and fairly complete thalli, with 4.5 and 5 cm as their largest diameter respectively, and both with a few well developed gyrose apothecia. In addition there is one large thallus fragment, pluss several smaller fragments, all identifiable as typical *Umbilicaria cinereorufescens*. It is not possible to unambiguously identify which of these items is the thallus depicted as fig. 10, plate XI in Schaerer's *Umbilicariae Helveticae* (1823). As McNeill et al. (2006: Art. 8.2) allow for the typification of a species on multiple small plants, we hereby designate as Lectotype (designated here) of *Umbilicaria cinereorufescens* (Schaer.) Frey the entire collection: Herbarium Genavense (G) G00053127 (pin code number), and also labelled in pencil 20050103/4.

Acknowledgements

The author thanks Le Conservateur principal Philippe Clerc at G for his kind cooperation in retrieving specimens from the Herbarium Schaerer. Thanks also to Professors Leif Tibell (UPS) and Per Magnus Jørgensen (BG), and First curator Einar Timdal (O) for valuable comments and suggestions.

Literature cited

- Arnold F. 1878. Lichenologische Ausflüge in Tirol. 18 & 19. Verhandlungen des zoologisch-botanischer Gesellschaft Wien 28: 247-296.
- Frey E. 1929. Beiträge zur Biologie, Morphologie und Systematik der Umbilicariaceen. Hedwigia 69: 219-252.
- Frey E. 1931. Weitere Beiträge zur Kenntnis der Umbilicariaceen. Hedwigia 71: 94-119.
- Hestmark G. 1990. Thalloconidia in the genus *Umbilicaria*. Nordic Journal of Botany 9: 547-574.
- Hestmark G. 1997. Species diversity and reproductive strategies in the family *Umbilicariaceae* on high equatorial mountains - with remarks on global patterns. Bibliotheca Lichenologica 68: 195-202.
- Krog H, Swinscow TDV. 1986. The lichen genera *Lasallia* and *Umbilicaria* in East Africa. Nordic Journal of Botany 6: 75-85.
- Linnaeus C. 1753. Species Plantarum. 1ed. Stockholm.
- Llano GA. 1950. A Monograph of the Lichen Family *Umbilicariaceae* in the Western Hemisphere. Navexos P-831. Office of Naval Res. Dep. Navy, Washington, D. C.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Regnum Vegetabile 146. 568 p.
- Poelt J. 1977. Die Gattung *Umbilicaria* (*Umbilicariaceae*). Flechten des Himalaya 14. Khumbu Himal 6/3: 397-435.

- Posner B, Feige GB, Huneck S. 1992. Studies in the Chemistry of the Lichen Genus *Umbilicaria* Hoffm. Zeitschrift für Naturforschung 47c: 1-9.
- Schaerer LE. 1817. Gyrophorum helveticarum adumbratio, ex majori opere manuscripto excerpta. Naturwissenschaftlicher Anzeiger der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften. 1 July, Vol. 1: 6-8.
- Schaerer LE. 1823. *Umbilicariae* Helveticae. In: N. C. Seringe (ed.) Musée Helvétique d'Histoire-Naturelle (Partie Botanique) Tome I: 85-114. Tab. X-XIII. Bernae.
- Schaerer LE. 1826a. Lichenes helvetici exsiccati...Fasc. 5-6. Nos. 101-152. Bernae.
- Schaerer LE. 1826b. Lichenum helveticorum spicilegium. [Pars prima.] Sectio secunda. Lichenum Exsiccatum fasciculos V. et VI illustrans. p. [i-vi], 53-100. Bernae, Typis Ludov. Alberti Haller.
- Schaerer LE. 1850. Enumeratio critica lichenum europaeorum quos ex nova methodo digerit. Bernae. Sumtibus auctoris excudebat officina Staempfliana.
- Wei J, Jiang Y. 1993. The Asian *Umbilicariaceae*. Mycosystema Monographicum Series No. 1. International Academic Publishers. Beijing.

Clitopilus amygdaliformis, a new species from tropical China

ZHU L. YANG

fungi@mail.kib.ac.cn

Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany,
Chinese Academy of Sciences, Kunming 650204, Yunnan, China

Abstract—*Clitopilus amygdaliformis* is described and illustrated as new from tropical China. It is characterized by its white to chalk white, small to medium-sized basidioma with an eccentric stipe, absence of pleuro- and cheilocystidia, and broadly amygdaliform to limoniform basidiospores with 5–6 prominent longitudinal ridges and a distinct suprahilar depression. It was regarded as *C. prunulus*, but the latter has a pileus often with somewhat grayish tinge, a central to slightly eccentric stipe, longer and narrower fusiform basidiospores and a temperate habitat.

Key words—taxonomy, *Entolomataceae*, *Agaricales*, *Basidiomycota*

Introduction

The genus *Clitopilus* P. Kumm. (*Entolomataceae*, *Agaricales*) in China has received little study, although a few species, namely *C. apalus* (Berk. & Broome) Petch, *C. crispus* Pat., *C. gigantosporus* M. Zang, *C. hobsonii* (Berk.) P. D. Orton, *C. prunulus*, *C. scyphoides* f. *omphaliiformis* (Joss.) Noordel., have been recorded (Bi et al. 1997, Chang & Mao 1995, Chou 2005, Chou & Chang 2005, Yang 2000, Zang 2001). In this study, collections made from southern parts of China, including Taiwan, were re-examined. It turned out that an undescribed species was collected from the vast regions with tropical and subtropical forests. It is reported herein.

Materials and methods

Specimens were annotated and photographed in the field, dried in an electric drier, and then deposited in herbaria. Herbarium abbreviations follow Holmgren et al. (1990) but with one exception that is not included in Index Herbariorum: HKAS—the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences.

Revived tissues were mounted in 5% KOH for microscopic examination. The abbreviation [*n/m/p*] shall mean *n* basidiospores measured from *m* basidiocarps of *p* collections. Dimensions of basidiospores excluding the apiculus are given with notation of the form (*a*) *b*-*c* (*d*). The range *b*-*c* contains a minimum of 90% of the measured values. Extreme values *a* and *d* are given in parentheses. *Q* refers to the length/width ratio of basidiospores; $\bar{Q}$ refers to the average *Q* of all basidiospores $\pm$ sample standard deviation.

Taxonomy

Clitopilus amygdaliformis Zhu L. Yang, sp. nov.

Figs. 1-4

MYCOBANK MB 510601

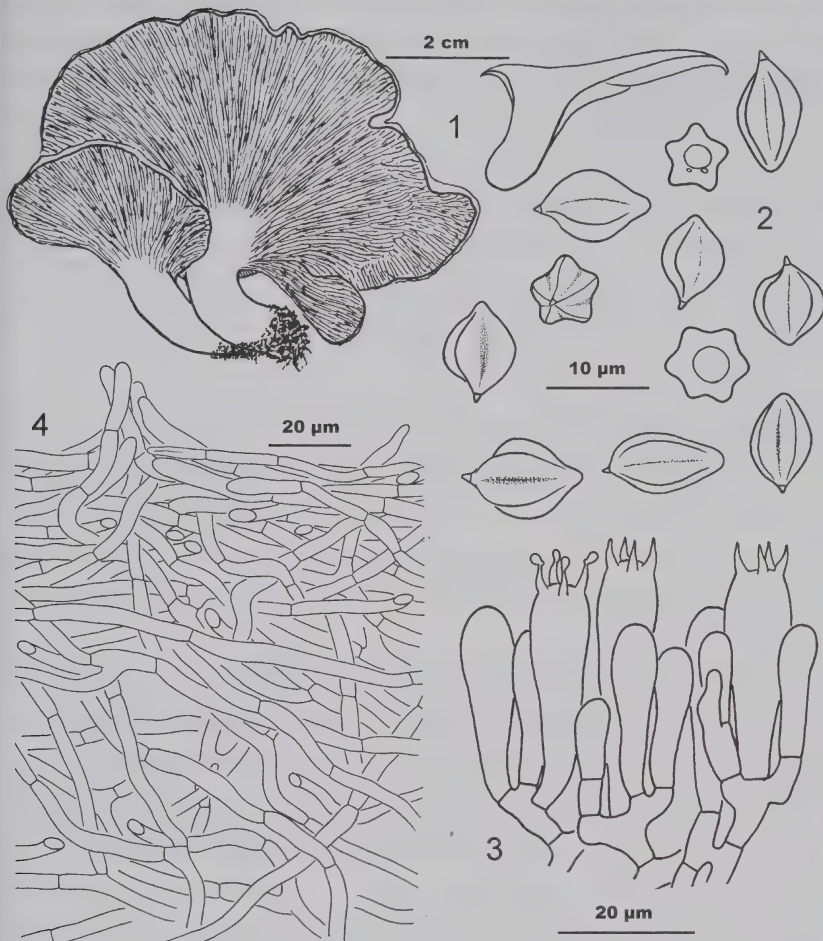
Name misapplied to the present species: *Clitopilus prunulus* sensu W. N. Chou, Fung. Flora Taiwan 3: 987, fig. 25 (2005); non *Clitopilus prunulus* (Scop.: Fr.) P. Kumm., Führ. Pilzk.: 97 (1871).

Pileus 2-8(11) cm *latus*, *convexus vel applanatus*, *albus vel albidus*, *siccus*, *glaber*, *marginē incurva et undulata*. *Lamellae decurrentes*, *primo albae deinde pallide roseolae*, 3 mm *latae*. *Stipes* 1-4(6) $\times$ 0.2-1 cm, *subcylindricus*, *albus vel albidus*, *excentricus*, *exannultus*, *albus vel albidus*. *Caro alba*. *Basidia* 23-36 $\times$ 8-10 μ m, *clavata*, *hyalina*, 4-sporigera. *Basidiosporae* (7.0) 8.0-11.5 (13.0) $\times$ 6.0-8.0 (8.5) μ m, *in aspectu frontali et obliquo amygdaliformes vel limoniformes*, *porcis longitudinalibus manifestis*, *in aspectu polari valde angulatis*, 5-6 (7) *paginulis praeditis*. *Pleurocystidia et cheilocystidia absentes*. *Epicutis pilei ex hyphis repentibus cylindricis non-incrustatis composita*. *Fibulae absentes*. *Habitatio: terrestris*. *Holotypus*: L.F. Zhang 187 (HKAS 42473), 17 July 2003, Yunnan, China.

Etymology: *amygdaliformis*, amygdaliform, referring to the form of the basidiospores.

Basidiomata (Fig. 1) small to medium. **Pileus** 2-8 (11) cm in diam., convex to plano-convex, often slightly depressed above the stipe, white to chalk white, but with cream colour over disc, slightly viscid when wet, glabrous; margin at first incurved, then straight, often undulate. **Lamellae** decurrent, whitish, then pinkish, crowded, up to 3 mm in height; edge entire and concolorous; lamellulae numerous. **Stipe** 1-4 (6) $\times$ 0.2-1 cm, white to whitish, unchanging, usually eccentric, occasionally nearly lateral, subcylindrical, smooth, basal part sometimes with white cottony mycelium. **Annulus** absent. **Context** 2-5 mm in thickness, white, unchanging; odor none or farinaceous; taste mild.

Basidia (Fig. 3) 23-36 $\times$ 8-10 μ m, clavate, hyaline, 4-spored, rarely 1- or 2-spored; sterigmata 3-4 (5) μ m long; no clamps observed on basal septa. **Subhymenium** composed of hyphal segments 3-6 μ m in diam. Lamellar trama composed of more or less regularly arranged, branching and anastomosing hyphae 3-12 μ m in diam.; oleiferous hyphae rare. **Basidiospores** (Fig. 2) [96/4/3] (7.0) 8.0-11.5 (13.0) $\times$ 6.0-8.0 (8.5) μ m, $\bar{Q}$ = (1.07) 1.14-1.54 (1.83) ($\bar{Q}$ = 1.33 $\pm$ 0.14), nearly colorless and hyaline, thin- to slightly thick-walled (wall < 0.5 μ m thick),



Figs. 1-4: *Clitopilus amygdaliformis* (holotype). 1. Basidiomata; 2. Basidiospores in side view, ventral view and polar view; 3. Subhymenium and hymenium with basidia at different stages of development. 4. Pileipellis and subcutis. Note terminal cells of pileipellis often grouped into fascicles on pileal surface; subcutis composed of irregularly and somewhat loosely arranged hyphae.

amygdaliform to limoniform in side view and often with a distinct suprahilar depression, limoniform to sometimes nearly ovoid in ventral view, strongly angled in polar view, with 5-6 (7) obvious longitudinal ridges; ridegs 1-1.5 µm in height. **Pleurocystidia** and **cheilocystidia** absent. **Pileipellis** (Fig. 4) a cutis composed of more or less radially arranged, repent, colorless and hyaline, non-encrusted filamentous hyphae 2-5 µm in diam.; terminal cells subcylindric,

fusiform or narrowly clavate, 3-7 μm in diam., on pileal surface often grouped into fascicles; subcutis composed of more or less irregularly and somewhat loosely arranged, thin-walled, colorless and hyaline filamentous hyphae 3-6 μm in diam. **Clamps** absent in all tissues.

Habit, habitat, distribution and season — Single or groups, on soil in broad-leaved (*Lithocarpus*, *Ternstroemia*) or coniferous (*Pinus*) forests; China (Taiwan and Yunnan). July to August.

COLLECTIONS EXAMINED—China, YUNNAN PROVINCE, BAOSHAN MUNICIPALITY, Bawan, alt. 2100m, 17.VII.2003, L.F. Zhang 187 [HOLOTYPE, HKAS 42473]. TAIWAN PROVINCE, NANTOU COUNTY, Yuanfeng, 24°07'N, 121°14'E, alt. 2750m, 20.VII.1999, W.N. Chou CWN 4390 [TNM-F 13317, as *C. prunulus* by Chou (2005)]; *ibid*, 24°07'N, 121°13'E, alt. 2800m, 10.VIII.2000, W.N. Chou and Y.P. Yen CWN 4757 [TNM-F 14390].

Comments—*Clitopilus amygdaliformis* is characterized by its white to chalk white, small to medium-sized basidioma with an eccentric stipe, absence of pleuro- and cheilocystidia, and broadly amygdaliform to limoniform basidiospores with 5-6 prominent longitudinal ridges and a distinct suprahilar depression. It should be placed in *Clitopilus* section *Clitopilus* due to its well developed stipe and large basidiospores with less than 7 prominent longitudinal ridges (Singer 1986).

In section *Clitopilus* five species, namely *C. griseobrunneus* T.J. Baroni & Halling, *C. lignyotus* Hongo, *C. prunulus*, *C. paxilloides* Noordel. and *C. quisquiliaris* (P. Karst.) Noordel., have been recognized (Baroni & Halling 2000). *Clitopilus griseobrunneus*, originally described from Costa Rica, differs from *C. amygdaliformis* by its brown to grayish brown pileus, the usually central stipe, much longer basidiospores, and dark brown incrusting hyphae in the pileipellis with subcapitate terminal elements (Baroni & Halling 2000). *Clitopilus lignyotus*, originally described from Japan, differs from *C. amygdaliformis* by its grayish brown to blackish brown pileus, the usually central stipe, and much narrower basidiospores (Hongo 1954). *Clitopilus paxilloides*, originally described from Norway, has a stouter, thicker-fleshed basidioma with a grey-brown pileus with strongly involute margin or grey-brown spots on the pileus surface, a grey-brown to greyish stipe, narrower basidiospores with higher Q (1.45-2.1), and strongly encrusting pigment in the pileipellis (Noordeloos 1993). *Clitopilus prunulus*, originally described from Europe, usually has a pileus with somewhat grayish tinge, a central or only slightly eccentric stipe, longer and narrower fusiform basidiospores with 5-8 longitudinal ridges and size of 9-13 $\times$ 4-6.5 (8) μm with much higher Q (1.3-2.0) (Hansen & Knudsen 1992, Noordeloos 1988, 1993, Pegler & Young 1971, 1975, Yang 2000). Furthermore, *C. prunulus* is distributed in northern temperate regions. *Clitopilus quisquiliaris* is only known from Nordic regions of Europe and differs from *C. amygdaliformis* by its

reddish brown pileus, smaller basidiospores, and habit of growing on enriched soils (Hansen & Knudsen 1992, Noordeloos 1981, 1993).

In the field in tropical China, *C. amygdaliformis* may be confused with *C. apalus* var. *apalus*, *C. crispus* and *C. orientalis* T.J. Baroni & Watling, all of which were originally described from tropical south East Asia and South Asia, and found in tropical China, and *C. apalus* var. *macrosporus* T.J. Baroni & Watling, originally described from Uganda, Africa. However, all these taxa possess much smaller basidiospores with lower but more (7-12) longitudinal ridges. Furthermore, *C. apalus* usually has smaller basidiomata, *C. crispus* has radially arranged fine ridges on the pileus with a subfimbriate margin, and *C. orientalis* has cheilocystidia (Baroni & Watling 1999, Pegler 1977, 1986, Singer 1978). *Clitopilus chalybescens* T.J. Baroni & Desjardin, described from Thailand (Baroni et al. 2001), differs from *C. amygdaliformis* by its grayish blue discoloration of the infundibuliform pileus and the central stipe with age, subcapitate pileocystidia and significantly smaller ellipsoid basidiospores with 8-10 longitudinal ridges.

Acknowledgments

This study was supported by the Knowledge Innovation Program of the Chinese Academy of Sciences (KSCX2-YW-G-025) and by the National Science Fund for Distinguished Young Scholars (No. 30525002) of the National Natural Science Foundation of China. The author is very grateful to Dr. S. H. Wu, National Museum of Natural Science, Taichung for allowing the author access to the specimens in the Herbarium of the museum, and using his laboratory to study the collections. The author thanks Dr. T. J. Baroni, State University of New York College at Cortland, and Dr. T. H. Li, Guangdong Institute of Microbiology, for reviewing the manuscript, and Prof. Z. W. Zhao, Yunnan University, and Prof. Baroni for sending related literature.

Literature cited

- Baroni TJ, Desjardin DE, Hywel-Jones N. 2001. *Clitopilus chalybescens*, a new species from Thailand. *Fungal Diversity* 6: 13-17.
- Baroni TJ, Halling RE. 2000. Some *Entolomataceae* (Agaricales) from Costa Rica. *Brittonia* 52: 121-135.
- Baroni TJ, Watling R. 1999. Taxonomic and mycogeographic notes on some Malaysian fungi IV. Notes on *Clitopilus* and *Rhodocybe*. *Mycotaxon* 72: 57-72.
- Bi ZS, Li TH, Zhang WM, Song B. 1997. A preliminary agaric flora of Hainan Province. Guangdong Higher Education Press: Guangzhou (China). 388 pp. (in Chinese).
- Chang ST, Mao XL. 1995. Hong Kong mushrooms. The Chinese University of Hong Kong: Hong Kong (China). 470 pp.
- Chou WN. 2005. *Clitopilus*. In: Tzean SS, Hsieh WH, Chang TT, Wu SH (eds). *Fungal flora of Taiwan*. Vol. 3: 957-1422. National Science Council: Taipei (China).
- Chou WN, Chang TT. 2005. *Mushrooms of Taiwan*. Yuan-Liou Publishing Co., Ltd.: Taipei (China). 439 pp. (in Chinese).

- Hansen L, Knudsen H (eds). 1992. Nordic macromycetes. Vol. 2. Nordsvamp: Copenhagen (Denmark). 474 pp.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: herbaria of the world. 8th edition. New York Botanical Garden: New York (USA). 693 pp.
- Hongo T. 1954. Notes on Japanese larger fungi (5). Journal of Japanese Botany 29: 87-92.
- Noordeloos ME. 1981. *Entoloma* subgenera *Entoloma* and *Allocybe* in the Netherlands and adjacent regions with a reconnaissance of their remaining taxa in Europe. Persoonia 12: 153-256.
- Noordeloos ME. 1988. Family *Entolomataceae*. In: Bas C, Kuyper ThW, Noordeloos ME, Vellinga EC (eds). Flora agaricina neerlandica. Vol. I. A. A. Balkema: Rotterdam (Holland). 182 pp.
- Noordeloos ME. 1993. Studies in *Clitopilus* (*Basidiomycetes*, *Agaricales*) in Europe. Persoonia 15: 241-248.
- Pegler DN. 1977. A revision of *Entolomataceae* (*Agaricales*) from India and Sri Lanka. Kew Bulletin 32: 189-220.
- Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bulletin Additional Series 12: 1-519.
- Pegler DN, Young TWK. 1971. Basidiospore morphology in the *Agaricales*. Nova Hedwigia Beiheft 35: 1-210.
- Pegler DN, Young TWK. 1975. Basidiospore form in the British species of *Clitopilus*, *Rhodocybe* and *Rhodotus*. Kew Bulletin 30: 19-32.
- Singer R. 1978. Keys for the identification of the species of *Agaricales* II. Sydowia 31: 193-237.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th edit. Koeltz Scientific Books: Koenigstein (Germany). 988 pp.
- Yang ZL. 2000. Notes on five common but little known higher Basidiomycetes from tropical Yunnan, China. Mycotaxon 74: 45-56.
- Zang M. 2001. Two new tropical mycotaxa from Yunnan, China. Acta Botanica Yunnanica 23: 295-297.

**First record of the genus *Byssosphaeria* (Pleosporales)
in Mexico and Venezuela**

ROSARIO MEDEL

rosario.medel@inecol.edu.mx

Instituto de Ecología, Unidad de Micología

Apartado postal 63, Xalapa 91000, Veracruz, México

Abstract—The genus *Byssosphaeria* is recorded for first time from Mexico and Venezuela. *B. jamaicana*, is recorded from Mexico and *B. schiedermayeriana* from Venezuela, both species were found in cloud forests.

Key words—Ascomycota, Melanommataceae

Byssosphaeria Cooke is an ascomycete that belongs to the order *Pleosporales* and includes at least 10 widely distributed species (Kirk et al. 2001). Bibliographic information about this genus is scarce (Barr 1984, Hyde et al. 1999). The *Pleosporales* contain 179 genera (Kirk et al. 2001) and is a group of fungi that is little known in Mexico. According to Medel et al. (1999) only three genera had been reported by 1996: *Sporormia* De Not., *Sporormiella* Ellis & Everh. and *Delitschia* Auersw. (Ahmed & Cain 1972, Udawaga & Kobayasi 1979). On the other hand there are no records of this genus from Venezuela (Iturriaga et al. 2000). These constitute the first records of the genus *Byssosphaeria* for both countries.

The material studied was mounted in KOH 5% and Melzer's iodine reagent. The specimens are deposited in the Mycological Collection of the Instituto de Ecología (XAL).

Byssosphaeria jamaicana (Sivan.) M.E. Barr, Mycotaxon 20: 34, 1984. Figs. 1-5
= *Herpotrichia jamaicana* Sivan., Mycol. Pap. 127: 35, 1971.

Ascomata 0.3–0.5 mm in diameter, globose, with the pore region almost plane, dark brown externally, surface roughened, with a pale brown ring around the small ostiole, stroma with appendages, more evident when stromata are crowded. Pseudoparaphyses up to 1 μ m diameter. Asci 130–135 x 11–12 μ m, with eight spores, cylindric-clavate with a stalk. Ascospores 30–35 (–38) x 5–7

(–8) μm , fusiform, 1–3 septate, markedly constricted in the central region, hyaline to olivaceous brown, with the ends dark and acute.

Habitat: gregarious, on *Quercus* fruit cupules, on the ground, in cloud forests at 1400 m altitude.

Specimen examined—MEXICO. VERACRUZ. Municipality of San Andrés Tlalnehuayocan, San Antonio Hidalgo, 11/XI/1999, *Jarvio* 379 (XAL).

Notes—The pale brown region surrounding the ostiole, the size of ascospores, and their acute dark ends are diagnostic characters (Barr 1984). This species can be distinguished from *B. salebrosa* (Cooke & Peck) M.E. Barr, which has spores (30–) 40–50 $\times$ (6–) 7–9 μm , with 1–5 septa and ascomata without appendages. It is also different from *B. schiedermayeriana* (Fuckel) M.E. Barr, which has a bright orange zone around the ostiole. *B. jamaicana* is also reported from Puerto Rico, Trinidad and Jamaica (Barr 1984), who noted that “It is probably much more widespread than these records indicate. I suspect some collections identified as ‘*Herpotrichia schiedermayeriana* with pallid pore region’ belong instead to *B. jamaicana*.” She reported this species on decorticated rotting wood, but the material studied here was growing on *Quercus* fruit cupules.

Byssosphaeria schiedermayeriana (Fuckel) M.E. Barr, Mycotaxon 20: 34, 1984.

Fig. 6

= *Herpotrichia schiedermayeriana* Fuckel, Jahrb. Nass. Ver. Naturk. 27–28: 27, 1873 (for an extensive synonymy see Barr, 1984).

A complete description of this species is provided in Hyde et al. (1999), and the material also fits well with the description given by Barr (1984). The material studied shows clearly the mucilaginous sheaths at the ends of the ascospores, which is unique in this species.

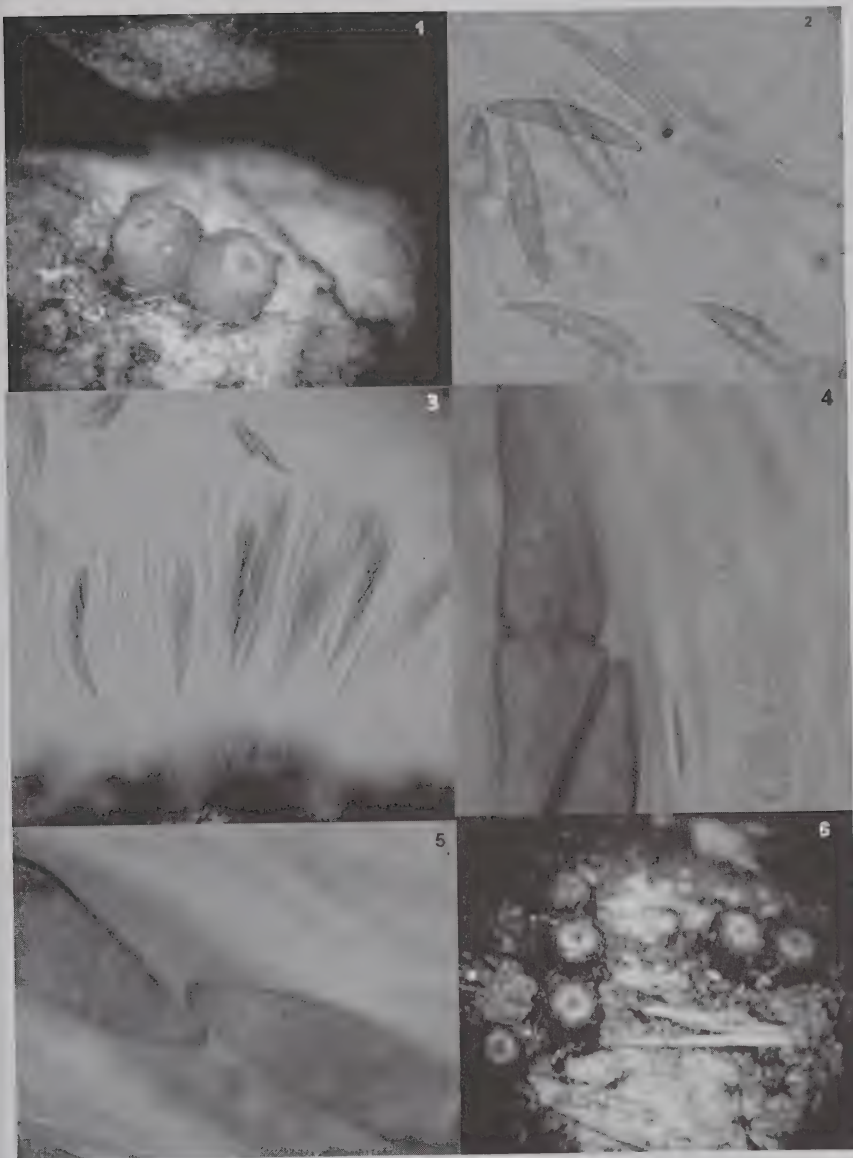
Habitat: gregarious, on decaying wood, in cloud forests.

Specimen examined—VENEZUELA. ARAGUA. Parque Nacional Henry Pittier, Rancho Grande Biological Station 29/VIII/ 1999, *Medel* 730-b, *Chacón* 5190 (both in XAL).

Notes—The diagnostic characters of this species are the bright orange region around the ostiole and the ascospore size, 1–3 septate with a mucilaginous sheath. *B. schiedermayeriana* is known from North and South America, Europe, Africa, Asia, Australia, Malaysia and the Philippines (Barr 1984, Hyde et al. 1999) and is recorded here for the first time for Venezuela.

Acknowledgments

Thanks to Dr. Gastón Guzmán from Instituto de Ecología at Xalapa for critically reading this paper, also to Dr. Fernando Fernandez (Field Museum), especially to Dr. Richard Korf for critical review and observations to improve this work, and to Juan Lara Carmona (Instituto de Ecología) for help in the herbarium work.



Figs. 1-6. 1-5. *Byssosphaeria jamaicana*, 1: stromata (10x); 2: ascospores (100x); 3: Asci and ascospores (40x); 4: ascospores showing the septa markedly constricted in the central region (100x); 5: Ascospores showing the dark ends (100x). Fig. 6. *B. schiedermayeriana*: stromata (10x). Photographs R. Medel, from Jarvio 379 (Figs.1-5) and Medel 730-b (Fig. 6).

Literature cited

- Ahmed SI, Cain RF. 1972. Revision of the genus *Sporormia* and *Sporormiella*. Can. Journ. Bot. 50: 419-477.
- Barr ME. 1984. *Herpotrichia* and its segregates. Mycotaxon 20: 1-38.
- Kirk P, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the fungi. 9 ed. CABI Bioscience, Bakeham Lane, UK.
- Iturriaga T, Páez I, Sanabria N, Holmquist O, Bracamonte L, Urbina H. 2000. Estado actual del conocimiento de la Micobiota en Venezuela. PNUD, USB, Caracas, Venezuela.
- Hyde K, Goh TK, Taylor JE, Fröhlich J. 1999. *Byssosphaeria*, *Chaetosphaeria*, *Niesslia* and *Ornatisspora* gen. nov. on palm. Mycological Research 103: 1423-1439.
- Medel R, Guzmán G, Chacón S. 1999. Especies de macromicetos citadas de México. IX. Ascomycetes parte III: 1983-1996. Acta Bot. Mexicana 46: 57-72.
- Udagawa S, Kobayasi K. 1979. Coprophilous fungi from Mexican Volcano Popocatepetl. Journ. Japan Bot. 54:1-8.

Phyllachora tengchongensis sp. nov. and a new record of *Phyllachora* (*Phyllachorales*) from China

NA LIU^{1,2} & LIN GUO^{1*}

liuna3456@163.com & guol@sun.im.ac.cn

¹Key Laboratory of Systematic Mycology and Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

²Graduate University of Chinese Academy of Sciences
Beijing 100049, China

Abstract—A new species, *Phyllachora tengchongensis* on *Miscanthus floridulus* and a new Chinese record, *Phyllachora americana* on *Capillipedium parviflorum* are reported.

Key words—*Sordariomycetidae*, tar spot, taxonomy

A new species of *Phyllachora* on leaves of *Miscanthus floridulus* was collected from Yunnan and Hunan Provinces in 2005. Two species of *Phyllachora* have been recognised on the genus of *Miscanthus*: *Phyllachora miscanthi* Syd. & P. Syd. (Sydow & Sydow 1917, Parbery 1967, 1971) and *Phyllachora ischaemi* Syd. & P. Syd. (Parbery 1967). *Phyllachora emeishana* J.Y. Li & H.R. Luo (Luo 1984) was described in Luo's master dissertation, so it was not effectively published. The new species of *Phyllachora* reported here differs from *Phyllachora miscanthi* in having narrow ascospores, while the latter has broadly ellipsoid ascospores measuring 18–24 x 12–14 µm. The new species differs from *Phyllachora ischaemi* in having large, oblong ascospores with one end acute or ovate-acuminate. Thus, a new species is described as:

Phyllachora tengchongensis Na Liu & L. Guo, sp. nov.

Figs. 1–4

MYCOBANK MB510598

Maculae epiphyllae, 0.3–1.7 x 0.3–0.8 mm, nigrae, nitidae. *Cellulae conidiogenae* 14–20 x 1.4–1.8 µm, cylindricae. *Conidia* 16–25 x 0.2 µm, hyalina, filiformia. *Ascomata* 135–740 x 100–260 µm, supra epidermidem evoluta, ellipsoidea vel irregularia. *Asci* 93–159 x 15–23 µm, octospori, clavati, unitunicati, pedunculati. *Ascosporae* 15–26 x 5–10 µm, uniseriatae

*corresponding author

vel irregulariter biseriatae, unicellulares, hyalinae, anguste ellipsoideae, oblongae, extremo acutae vel ovato-acuminatae.

Leaf spot: blackened regions sparse, roughly circular or ellipsoidal, 0.3–1.7 x 0.3–0.8 mm, shining black, 1- to 2- loculate, the ostiole inconspicuous, blackened regions may be visible from both sides of the leaves.

Anamorph: conidiogenous cells arranged in groups, cylindrical, tapering towards the apices, 14–20 x 1.4–1.8 μm . Conidia 16–25 x 0.2 μm , filiform, some curved, thin-walled, hyaline, aseptate.

Teleomorph: ascomata 135–740 x 100–260 μm , epigenous, immersed in the upper epidermis layer of the leaves, ellipsoidal, some irregularly shaped due to compression forces, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 68 μm thick, composed of epidermis cells which are occluded by melanized material. Lower wall up to 43 μm thick. Lateral wall up to 43 μm thick, composed of thin-walled cells. Paraphyses up to 3 μm wide, thin-walled, gradually tapering, no branching, septate. Asci 93–159 x 15–23 μm , 8-spored, clavate, short pedunculate, thin-walled at maturity, unitunicate. Ascospores arranged uniseriate or irregularly biseriate, 15–26 x 5–10 μm , narrowly ellipsoid, oblong with one acute end or ovate-acuminate, one-celled, hyaline, thin-walled, smooth, guttulate, with a gelatinous sheath. When over-matured, the ascospores become yellow.

Specimens examined—On living leaves of *Miscanthus floridulus* Warb. ex K. Schum. & Lauterb. (*Poaceae*), China, Yunnan, Tengchong, alt. 1600 m, 20 IX 2005, N. Liu, Z.Y. Li & L. Guo 146, HMAS 169551 (holotype); China, Hunan, Changde, Taiyang mountain, alt. 470m, 18 IV 2005, Z.Y. Li & L. Guo 23, HMAS 169552 (Paratype).

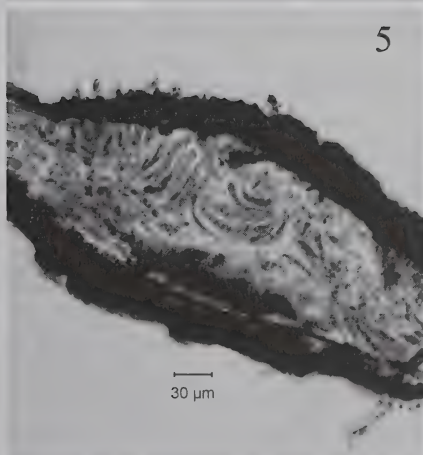
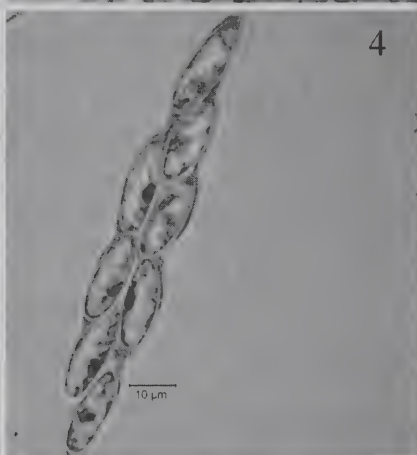
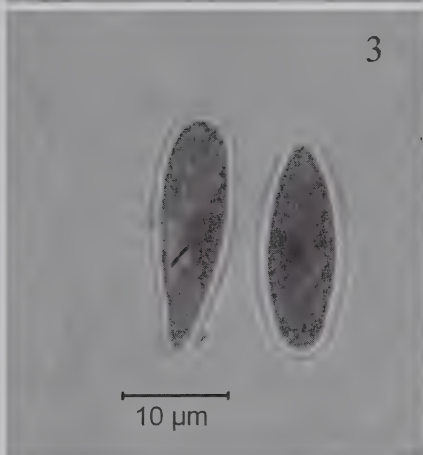
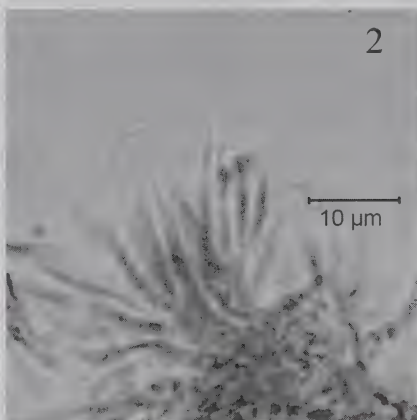
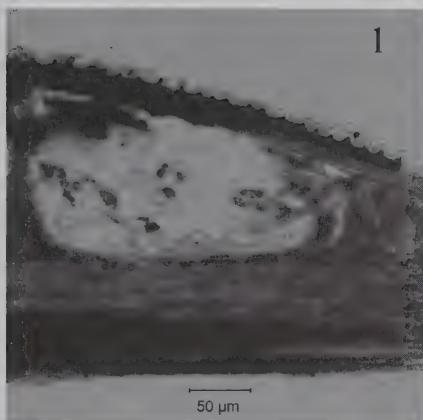
The specimen of *Phyllachora* on *Capillipedium parviflorum* was collected from Yunnan Province. Previously, only *Phyllachora ischaemi* was reported on *Capillipedium*, which often has slightly constricted ascospores (Parbery 1967, Pearce & Hyde 2006). The specimen collected by us has similar ascospores to *Phyllachora americana*, but no constriction at the centre, since the hosts are the same plants (*Andropogon micranthus* Kunth was synonymized with *Capillipedium parviflorum*, Chen et al. 1997), so we identified it as:

Phyllachora americana Parbery, Aust. J. Bot 15: 290, 1967.

Figs. 5-6

Leaf spot: blackened regions sparse, rarely aggregated, roughly circular, ellipsoidal, flattened, 0.5–1.7 x 0.2–0.5 mm, shining black, multi-loculate, sometimes up to 8- loculate, the ostiole inconspicuous, blackened regions can be seen from both sides of the leaves.

Figs. 1-4. *Phyllachora tengchongensis*. Fig. 1. Section through immersed ascoma. Fig. 2. Differential interference micrograph of conidia and conidiogenous cell. Figs. 3-4. Differential interference micrograph of ascus and ascospores. Figs. 5-6. *Phyllachora americana*. Fig. 5. Section through immersed ascoma. Fig. 6. Differential interference micrograph of asci and ascospores.



Anamorph: not seen.

Teleomorph: ascomata 125–425 x 50–95 μm , immersed in the mesophyll layer of the leaves, ellipsoidal, with well-developed, hyaline periphyses, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 45 μm thick. Lower wall up to 25 μm thick. Lateral wall up to 20 μm thick, composed of thin-walled cells. Paraphyses abundant, longer than asci, 2 μm wide, thin-walled, no branch, septate. Asci 73–105 x 10–15 μm , 8-spored, cylindrical, obtuse at apex, with apical ring, short pedunculate, thin walled at maturity, unitunicate. Ascospores arranged uniseriate or irregularly biseriate, 9.5–17.5 x 6–8 μm , ellipsoid, ovoid, guttulate, one-celled, hyaline, smooth, without a gelatinous sheath.

Specimens examined—on living leaves of *Capillipedium parviflorum* (R. Br.) Stapf, China, Yunnan, Tengchong, 20 IX 2005, N. Liu, Z.Y. Li, L. Guo 147, HMAS 169553.

Acknowledgements

The authors would like to express their thanks to Drs. Hyde, Shivas and Pearce for reading the manuscript and serving as pre-submission reviewers, to Dr. Pennycook for nomenclature review, to Dr. Chen Wenli (Institute of Botany, Chinese Academy of Sciences) for identifying the host plants, to Prof. Zhuang Jianyun for the corrections of Latin description. This study was supported by the Ministry of Science and Technology of the People's Republic of China (No. 2005DKA21401).

Literature cited

- Chen SL, Zhuang TD, Fang WZ, Sheng GY, Jin YX, Liu L, Sun BS, Hu ZH, Wang S. (eds.) 1997. Flora Reipublicae Popularis Sinicae, Tomus 10 (2), *Angiospermae, Monocotyledoneae, Gramineae (Poaee)* (5), Science Press, Beijing, 339 pp.
- Luo HY. 1984. Studies on graminicolous species and their divisional criteria of *Phyllachora* in China. Master's Dissertation. Northwest Agricultural college, Yangling, 110 pp.
- Parbery DG. 1967. Studies on graminicolous species of *Phyllachora* Nke. in Fckl. V. A taxonomic monograph. Austr. J. Bot. 15: 271–375.
- Parbery DG. 1971. Studies on graminicolous species of *Phyllachora* Nke. in Fckl. VI. Additions and corrections to Part V. Austr. J. Bot. 19: 207–235.
- Pearce CA, Hyde KD. 2006. *Phyllachoraceae* of Australia. Fungal Diversity Research Series 18: 1–308.
- Sydow H, Sydow P. 1917. Beitrag zur Kenntnis der Pilzflora der Philippinen-Inseln. Ann. Mycol. 15: 165–268.

New records of lichenicolous and lichenized fungi from Turkey

MEHMET GÖKHAN HALICI*

mghalici@erciyes.edu.tr

Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

MEHMET CANDAN & AYŞEN ÖZDEMİR TÜRK

mecandan@anadolu.edu.tr, aturk@anadolu.edu.tr,

Department of Biology, Faculty of Science, Anadolu University
Eskişehir, Turkey

Abstract—Six species of lichenicolous fungi (*Endococcus nanellus*, *Polycoccum dzieduszyckii*, *Polycoccum sporastatae*, *Stigmidium gyrophorarum*, *Weddellomyces heterochrous*, and *Zwackhiomyces lecanorae*) and one lichenized fungus (*Stereocaulon vesuvianum*) are reported for the first time from Turkey. Comments on their habitat and substrata and a short diagnosis are provided for each taxon.

Key words—*Ascomycota*, pyrenocarporous fungi, lichens

Introduction

Studies aiming to determine the lichenicolous fungal component of the biota of Turkey have intensified in the last three years (Halıcı et al. 2005, Hafellner & John 2006, Halıcı et al. 2006, Hawksworth & Halıcı 2007, Halıcı et al. 2007). Furthermore, Hafellner & John (2006) compiled the existing information along with new records, recognizing 63 taxa. Now, 74 infrageneric taxa of lichenicolous fungi are known from Turkey, but it is obvious that this number is too small when compared with other European countries (Faltynowicz 2003, Hawksworth 2003, Scholz 2000) and a total of at least 250 might be expected. Therefore, more studies on the lichenicolous fungi of Turkey are needed, as well as on the lichens of Turkey, to gain a sound knowledge of this element of the country's biota.

Here we aim to make a further contribution to our knowledge of the lichenicolous fungi of Turkey, and in addition report one of the host lichens encountered in this study as a new record for Turkey.

Materials and methods

The specimens are stored in ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey) and their accession numbers are given in parentheses after the locality details. The specimens were examined with a Leica MZ6 model stereomicroscope, and an Olympus BX51 microscope. Specimens were examined in water, 10% KOH, Lugol's iodine solution, or lactofuchsin. Spore measurements were generally carried out in KOH, but in the case of thin-walled spores the dimensions were also checked in water. The descriptions given below are the original descriptions of the specimens examined.

Species recorded

Endococcus nanellus Ohlert 1870

A detailed description is provided by Keissler (1930: 417-418).

The specimen was collected from the thallus of *Stereocaulon vesuvianum* on calcareous rocks. Ascomata perithecia, black, ~ 100 µm. Asci 8-spored. Ascospores 1-septate, pale brown, $8.5-13 \times 3-3.5$ µm. The size of the ascospores in the Turkish specimen is a little bigger than the size given by Keissler (1930), i.e. $8-9 \times 2-3$ µm. The hymenial gel turns red with Lugol's iodine solution without pre-treatment with K. The species seems to be commensalistic as no damage was evident on the host.

This boreal species is restricted to *Stereocaulon* species, especially to *S. tomentosum* (Zhurbenko 2000), and known from Sweden (Santesson 1993), Estonia (Suija 2005) and America (Diederich 2003).

MANISA: Salihli, West of Yağbastı Village, 38° 39' N, 28° 27' E, alt. 640 m, on thallus of *Stereocaulon vesuvianum* on calcareous rocks, 16 Aug. 2006, M. Candan (ANES 11014).

Polycoccum dzieduszyckii (Boberski) D.Hawksw. 1980

A detailed description is provided by Hawksworth & Diederich (1988).

The specimen was collected on the thallus of *Verrucaria calciseda* on limestone. Ascomata perithecia, erumpent, subglobose, black, 100-130 µm. Hamathecial filaments present, 1.5-2 µm wide. Asci clavate, c. 62×30 µm, consistently 2-spored. Ascospores brown, 1-septate, ellipsoid, cells ± equal in size, verruculose, $25-28 \times 8-11$ µm. The length of the ascospores is smaller in the Turkish specimen than the size given in Hawksworth & Diederich (1988), but considerable variation is to be expected when dealing with large ascospores. This species is primarily distinguished from the other species of the genus by the 2-spored asci and large ascospores (Hawksworth & Diederich 1988).

Known also from the British Isles and Poland, there growing on the thallus of *Verrucaria baldensis* (Hawksworth & Diederich 1988).

MANISA: Kula, Northwest of Kula, 38° 34' N, 28° 38' E, alt. 680 m, on thallus of *Verrucaria calciseda* on calcareous rocks, 14 Aug. 2006, M. Candan (ANES 10160).

Polycoccum sporastatae (Anzi) Arnold 1874

A detailed description is provided by Hawksworth & Diederich (1988).

The specimen was collected on the areoles of *Sporastatia testudinea* on siliceous rocks. Ascomata perithecia, immersed on the areoles of the host, associated with a superficial network of hyphae, 170–200 µm. Hamathecial filaments present, branched and anastomosed. Asci elongate-clavate, 8-spored. Ascospores distichously arranged, broadly ellipsoid, upper cell often slightly broader and rounded, the lower often attenuated, olivaceous brown at maturity, 22–23 × 10 µm. The specimens belonging to this species generally have 4-spored asci although 8-spored asci are also known (Hawksworth & Diederich 1988). However, we observed constantly 8-spored asci in the Turkish specimen. As stated by Atienza et al. (2003) for Spanish material, no galls were observed in the areoles infected by *S. testudinea* in the Turkish specimen. The Turkish specimen seems to be commensalistic as no damage was evident in the host areoles.

Known also from Germany (Triebel & Scholz 2001), Spain (Atienza et al. 2003), Asia (Triebel & Rambold 1991), Greenland (Alstrup et al. 2000), and North America (Triebel & Rambold 1991); growing on *Sporastatia testudinea* or *S. polyspora*.

ESKIŞEHİR: Bozdağ, Türkmen Hill, 39° 54' N, 30° 41' E, alt. 1500 m, on thallus of *Sporastatia testudinea*, on siliceous rocks, 21 Nov. 2006, M. Candan (ANES 10901).

Stereocaulon vesuvianum Pers. 1811

Detailed descriptions are provided by Øvstedal & Lewis Smith (2001) and Brodo et al. (2001).

This lichenized species was found on metal-rich, hard volcanic rocks in localities in the Kula volcanic area as given below. It formed compact tufts locally, especially in sites far from anthropogenic influences. Pseudopodetia 1.5–2.5 cm tall, erect, forming compact tufts, branched, hard and almost woody at the base, phyllocladia wart-like, crowded, greenish grey, central parts surrounded by paler-grey white swollen margins. Soredia very rarely observed. Cephalodia and apothecia were not observed in Turkish samples.

This widespread species is known from Antarctica (Øvstedal & Lewis Smith 2001), North and South America, Europe, Asia, and Australasia (Purvis et al. 1992).

MANISA: Kula, Northwest of the Kula town, 38° 34' N, 28° 39' E, alt. 700 m, on volcanic rocks, 14 Aug.2006, M. Candan (ANES 10171), Salihli, West of Demirköprü dam, 38° 36' N, 28° 18' E, alt. 210 m, on volcanic rocks, 15 Aug.2006, M. Candan (ANES 10170), Salihli, Northwest of Eminbey village, 38° 36' N, 28° 25' E, alt. 610 m, on volcanic rocks, 16 Aug.2006, M. Candan (ANES 11014).

Stigmidium gyrophorum (Arnold) D.Hawksw. 1975

A detailed description is provided by Triebel & Cáceres (2004)

The specimen was collected on the thallus of *Umbilicaria leiocarpa* and an unidentified *Umbilicaria* species on siliceous rocks. Few superficial brownish vegetative hyphae were observed. Ascomata perithecia, black, semi-immersed, ~ 80 µm. Haematecium absent in mature ascomata. Asci clavate, 8-spored. Ascospores colourless, 1-septate, with 1 oil droplet per cell, 15–20 × 7–9 µm. The specimen seems to be weakly pathogenic as some feint discolorations were observed in the host thallus.

Previously known from Europe and North America on thallus of *Umbilicaria* species (Triebel & Cáceres 2004) and Asia (Kondratyuk & Kudratov 2002).

KAYSERİ: Erciyes Mountain, North of Perikartın (North slopes of Erciyes Mountain), 38° 35' N, 35° 27' E, alt. 2300 m, on thallus of *Umbilicaria leiocarpa*, on siliceous rocks, 02 Jul.2006, leg. M. G. Halıcı (ANES 11026).

ESKİŞEHİR: Bozdağ, Türkmen Hill, alt. 1500 m, on thallus of *Umbilicaria* sp. on siliceous rocks, 16 Nov.2006, leg. M. Candan & T. Tay (ANES 10900).

Weddellomyces heterochrous Nav.- Ros. & Cl. Roux 1995

A detailed description is provided by Navarro-Rosinés & Roux (1995).

The specimen was collected on the areoles of an *Aspicilia* species on calcareous rocks which was K-. It seems to be highly pathogenic as ascomata production in the host lichen is suppressed and the thallus is deformed. Ascomata perithecia, black, opening irregularly by fragmentation of cephalothecioid plates. Hamatecium of branched and anastomosed interascal filaments. Asci 8-spored. Ascospores brown, 3-septate, the end cells always paler, 32–36(–40) × 11–13 µm.

Previously known only from Spain on the thallus of *Aspicilia calcarea* (Navarro-Rosinés & Roux 1995).

KARAMAN: Karadağ, 37° 23' N, 30° 57' E, alt. 2250 m, on thallus of *Aspicilia* sp. on calcareous rocks, 12 Jul. 2002, C. Özmen (ANES 10159).

Zwackhiomyces lecanorae (Stein) Nik. Hoffm. & Hafellner 2000

A detailed description is provided by Etayo (1994).

The specimen was collected on the areoles of *Lobothallia radiosa* growing on calcareous rocks. It seems to be commensalistic as no damage was evident in

the host thallus. Ascomata perithecia, black, ~ 0.2 mm diam, ostiole broad and urceolate, greenish. Hamathecium of branched and anastomosed interascal filaments. Asci 8-spored, $70 \times 11\text{--}12\text{ }\mu\text{m}$. Ascospores colourless, simple, tear-like, with many oil droplets, uniseriably arranged in asci, $14\text{--}15 \times 6\text{--}7\text{ }\mu\text{m}$.

Known on a wide range of crustose lichens on calcareous substrata, including *Aspicilia contorta*, *Candelariella aurella*, *Lecanora albenscens*, *L. crenulata*, *L. dispersa*, *Lecidella stigmata* and *Verrucaria parmigera* in Spain (Etayo 1994).

MANISA: Salihli, West of Yağbastı Village, $38^{\circ} 39' \text{ N}$, $28^{\circ} 27' \text{ E}$, alt. 640 m, on thallus of *Lobothallia radiosa* on calcareous rocks, 16 Aug.2006, M. Candan (ANES 10156).

Acknowledgements

We would like to thank David L. Hawksworth and Paul Diederich for reviewing this paper, and Pere Navarro-Rosinés for identifying our specimen of *Stigmidium gyrophorum*. This study was completed when MGH was based in the Facultad de Farmacia, Universidad Complutense de Madrid, under the direction of David L. Hawksworth with a scholarship from TUBITAK.

Literature Cited

- Alstrup V, Hansen ES, Daniels FJA. 2000. Lichenized, lichenicolous and other fungi from north and north-east Greenland. *Folia Cryptogamica Estonica* 37: 1-20.
- Atienza V, Calatayud V, Hawksworth DL. 2003. Notes on the genus *Polycoccum* (*Ascomycota*, *Decampiaceae*) in Spain, with a key to the species. *Lichenologist* 35: 125-135.
- Brodo M, Sharnoff SD, Sharnoff S. 2001. *Lichens of North America*. New Haven: Yale University Press.
- Diederich P. 2003. New species and new records of American lichenicolous fungi. *Herzogia* 16: 41-90.
- Faltynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. *Biodiversity of Poland* 6: 1-435.
- Halıcı MG, Orange A, Aksoy A. 2005. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. *Mycotaxon* 94: 249-252.
- Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. *Mycotaxon* 96: 13-19.
- Halıcı MG, Özdemir Türk A, Candan M. 2007. New records of pyrenocarpous lichenicolous fungi from Turkey. *Mycotaxon* 99: 201-206.
- Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*), with a key to accepted species. *Trans. Br. Mycol. Soc.* 90: 293-312.
- Hawksworth DL. 2003. The lichenicolous fungi of Great Britain and Ireland: an overview and annotated checklist. *Lichenologist* 35: 191-232.
- Hawksworth DL, Halıcı MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. *Lichenologist* 39: 121-128.
- Keissler K. 1930. Die Flechtenparasiten. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz 8: i- xi, 1-712.

- Kondratyuk SY, Kudratov I. 2002. New for Tajikistan lichenicolous and lichen forming fungi. *Ukrayins'kyi Botanichnyi Zhurnal* 59: 165-170.
- Navarro-Rosinés P, Roux C. 1995. La genre *Weddellomyces* (*Dothideales*, *Decampiaceae*) en Catalogne et en Provence. *Mycotaxon* 53: 161-189.
- Øvstedal DO, Lewis Smith RI. 2001. Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. Cambridge: Cambridge University Press.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. London: Natural History Museum Publications.
- Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. SBT-förlaget.
- Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. Schriftenreihe der Vegetationskunde 31: 1-298.
- Suija A. 2005. Lichenicolous fungi and lichens in Estonia I. *Ascomycota*. *Nova Hedwigia* 80: 247-267.
- Triebel D, Rambold G. 1991. On lichenicolous fungi from continental North America. *Mycotaxon* 42: 263-269.
- Triebel D, Scholz P. 2001. Lichenicolous fungi from Bavaria as represented in the Botanische Staatssammlung München. *Sendtnera* 7: 211-231.
- Triebel D, Cáceres MES. 2004. *Stigmidium*, pp. 703-707. In Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F. 2004. Lichen Flora of the Greater Sonoran Desert Region. Vol. 2. Tempe: Arizona State University.
- Zhurbenko MP. 2000. Key to the lichenicolous fungi occurring on the lichen genus *Stereocaulon* in the Russian Arctic. *Mikologija i Fitopatologija* 34: 19-22.

***Ripartitella* (Agaricales) from an Atlantic Forest in Pernambuco, Brazil**

FELIPE WARTCHOW¹, JAIR PUTZKE² & MARIA A. Q. CAVALCANTI¹

fwartchow@yahoo.com.br, jair@unisc.br, xiliamac@terra.com.br

¹*Universidade Federal de Pernambuco, Departamento de Micologia
Av. Prof. Nelson Chaves, s/n° CEP: 50670-901, Recife, PE, BRAZIL*

²*Universidade de Santa Cruz do Sul, Depto. de Biologia
CEP: 96815-900 Santa Cruz do Sul, RS, BRAZIL*

Abstract—This paper presents two neotropical species of *Ripartitella* collected at Northeast Brazil: *R. alba* is a new record from Brazil, and *R. brasiliensis* is cited for the first time from this Brazilian region. A key to species, descriptions, discussion, drawings and scanning electron microscopy (SEM) are provided.

Key words—*Agaricomycetidae*, neotropics, taxonomy, *Tricholomataceae*

Introduction

Ripartitella Singer was originally placed in *Agaricaceae* Cheval. tribe *Cystodermatae* Fayod, near to the lepiotoid genus *Cystoderma* Fayod, mainly because of the similarity of cystidia (Singer 1947, 1986). Some authors, using morphological and anatomical data (e.g., Pegler 1977, 1983, Ovrebo 1988, Franco-Molano 1993) and molecular data (Johnson & Vilgalys 1998), excluded these genera from *Agaricaceae* and transferred them to *Tricholomataceae* R. Heim ex Pouzar. Hawksworth et al. (1995) and Kirk et al. (2001) also considered these genera in *Tricholomataceae*, but Moncalvo et al. (2000, 2002) conclude that the taxonomic position of *Ripartitella* and *Cystoderma* remains unresolved.

In Brazil, only *R. brasiliensis* was previously reported (Singer 1950, 1953, Pegler 1997, Matheus et al. 2000, Okino et al. 2000).

Materials and methods

The basidiomes were collected at the tropical rain forest “Reserva Ecológica da Mata do Sistema Gurjaú” (8°14'21" S and 35°03'00" W) with 1077 ha, municipality of Cabo de Santo Agostinho, Pernambuco State, in Northeast Brazil (SECTMA 2001). The measurements of microscopic structures were

made from material mounted in 5% KOH. Line drawings were made with the aid of a camera lucida. Color naming and color codes follow Maerz & Paul (1950). Exsiccata were deposited in the Herbarium of the Mycology Department of the "Universidade Federal 'de Pernambuco'" (URM).

Material was prepared for scanning electron microscope (SEM) following Franco-Molano (1993), with some modifications: pileal and lamellae fragments were rehydrated for a few minutes in 10% NH_4OH and washed three times in distilled water; fixed in 1% OsO_4 in 0.1 M sodium-phosphate buffer; rinsed with the same buffer; dehydrated in a ethanol series (30, 50, 70, 90 and 100%, 10 min at each stage) and dried in a critical point dryer. The fragments were mounted on aluminum stubs with double-sided sticky tape, coated with gold, and observed in a JEOL 5600 SEM.

Taxonomy

Key for the species of *Ripartitella* found in Pernambuco

1. Pileus surface minutely floccose-tomentose, with yellow tonalities at the disc;
habit solitary *R. alba*
- 1'. Pileus surface with small brown squamules, mainly at the disc;
habit gregarious *R. brasiliensis*

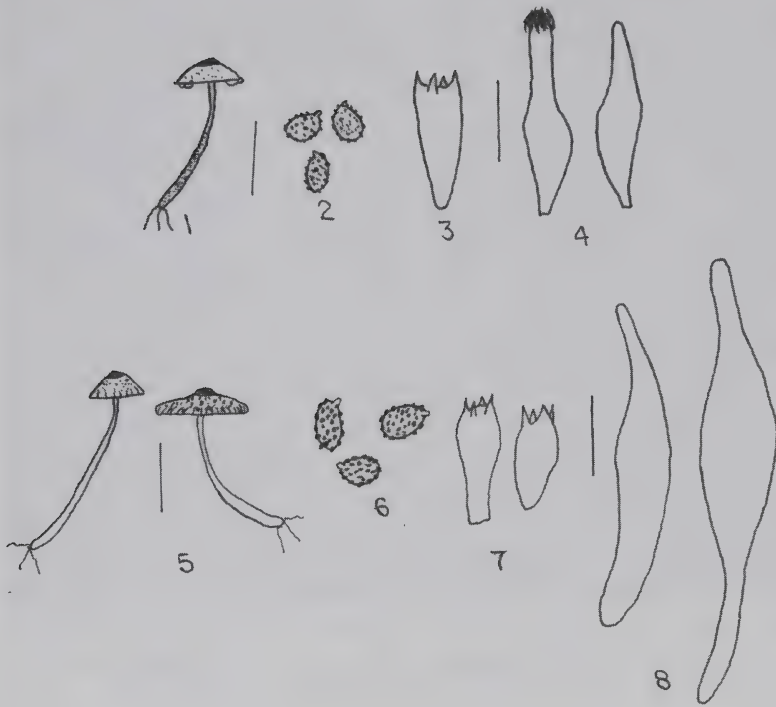
Ripartitella alba Halling & Franco-Mol., Mycologia 88: 669. 1996. FIGS. 1-4, 9-10.

Pileus 10 mm, convex broadly umbonate, white with light yellow (9D1) tints at disc; surface minutely floccose-tomentose with remnants of veil at margin. **Lamellae** adnexed, membranous, moderately crowded, white. **Stipe** 22×1 mm, central, cylindrical, white then yellowish at base, minutely floccose-tomentose, easily left at soil, rhizomorphs present. Context thin, white, fleshy, unchanging.

Basidiospores $4-5 \times 2.5-3.2 \mu\text{m}$, average $4.6 \times 2.7 \mu\text{m}$, $Q = 1.31-1.72$ (-2), subovoid to ellipsoid then occasionally elongate in side view, verrucose and echinulate, slightly thick walled, inamyloid, hyaline. **Basidia** $12.5-18 \times 5-6 \mu\text{m}$, clavate, 2 to 4 sterigmata. **Cystidia** very scarce, observed exclusively on side of the lamellae, approximately $24-27 \times 7.5 \mu\text{m}$, fusoid, thin walled, with crystals encrusting the apex immediately dissolving in KOH, but persisting in Melzer's reagent, thin walled, hyaline. **Pileipellis** formed by ascendant hyphae organized in rows, terminal elements $20-48 \times 5-15 \mu\text{m}$, subcylindrical to ovoid, smooth, moderately thick walled, hyaline. Hymenophoral trama irregular. Clamp connections present.

Habitat: solitary on rotten wood in tropical forest.

Material examined: BRAZIL. Pernambuco: Cabo de Santo Agostinho, Gurjaú ("Mata do Coxiu"), 19/VII/2004, F. Wartchow 16/2004 (URM 78672).



Figures 1–8: 1–4 *R. alba*: 1. Basidioma. 2. Basidiospores. 3. Basidium. 4. Cystidia.
5–8 *R. brasiliensis*: 5. Basidiomata. 6. Basidiospores. 7. Basidia. 8. Cystidia.
Scale bar 10 mm for basidiomata and 10 μ m for microstructures.

Distribution: Costa Rica (Halling & Franco-Molano 1996), Mexico (Bandala et al. 2005), the Caribbean (Great Antilles website <<http://www.cortland.edu/nsf/ga.html>>), Hawaii Islands and Colombia (see Macrofungi of Costa Rica website <<http://www.nybg.org/bsci/res/hall>>).

Remarks: This species differs from *Ripartitella brasiliensis* by the pallid and less squamulose surface of the pileus, smaller stature of basidioma and smaller basidiospores and cystidia (Halling & Franco-Molano 1996). Recently Bandala et al. (2005) reported *R. alba* with pileus ranging to (10–) 13–28 mm and brownish-orange to dull brownish-orange squamules in centre of pileus. These authors also suspect that *Lepiota armillarioides* Dennis and *Agaricus exsanguis* Mont. are two probably additional synonyms of *R. alba*.

In the Brazilian collection we observed a solitary habit and narrower spores, but several features agree with the original description of this species.

Ripartitella brasiliensis (Speg.) Singer, Lilloa 22: 452. 1951. FIGS. 5-8, 11-12.

Pileus 5–15 mm, campanulate at first then convex with a prominent umbo on maturity; surface white, smooth except the disc with densely placed small brown (“Talavera” 12A12) to dark brown (“Alamo” 14A12) squamules, margin finely sulcate. **Lamellae** adnexed, membranous, very crowded, white. **Stipe** 15–27 × 1–1.5 mm, central, cylindrical then slightly swollen at base in some specimens, with indistinct squamules concolorous to pileus, pale cream (“Polar Bear” 9B2) to pale brown (“Golden Wheat” 11D7); rhizomorphs numerous. Context thin, fleshy, white, unchanging.

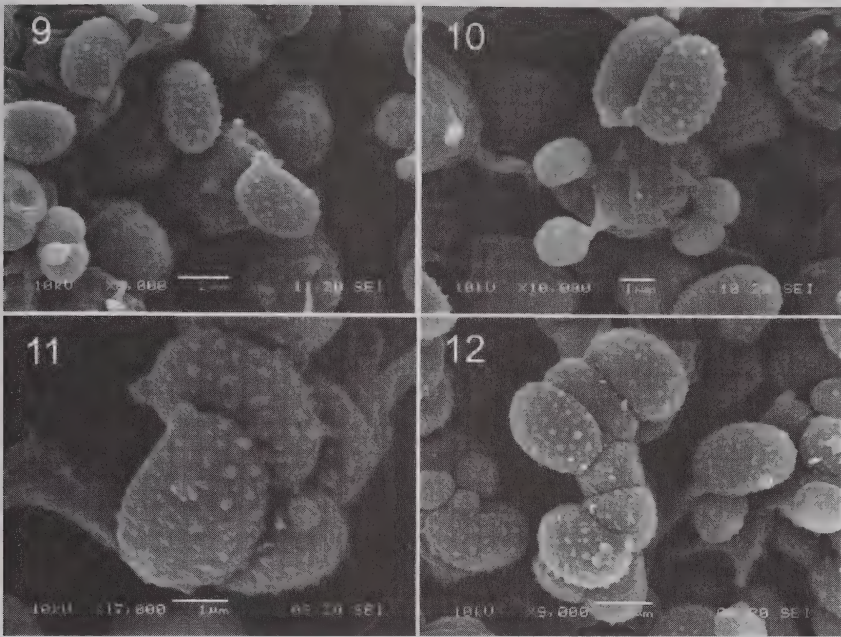
Basidiospores 4–5.8 (–6.2) × 2.5–3.8 µm, average 5 × 3 µm, Q = (1.56–) 1.67–2 (–2.16), ellipsoid to elongate in side view, distinctly verrucose and echinulate, slightly thickness walled, inamyloid, hyaline. **Basidia** 12.5–17.5 × 5–6 µm, clavate, 2 to 4 sterigmata. **Cystidia** scattered, mainly on side of the lamellae, 36–57 × 6.5–9 µm, lageniform, hyaline with yellowish wall in KOH; crystalline deposits at the top not observed, probably dissolved away. **Pileipellis** with ascendant hyphae organized in rows with more or less isodiametric terminal elements 6–15 µm diam., slightly thick walled, with yellowish-brown or slightly paler pigments. Hymenophoral trama regular to sub-regular. Clamp-connections present.

Habitat: gregarious to sub-caespitose on decayed wood in a tropical forest.

Material examined: BRAZIL. Pernambuco State, Cabo de Santo Agostinho, Gurjaú (“Mata do Xangô”), 14/V/2004, F. Wartchow 07/2004 (URM 78676; HCB 18238).

Distribution: USA (Murrill 1943 as *Lentodium floridanum*, Singer 1947), Trinidad (Dennis 1951 as *Collybia pseudoboryana*, 1952 as *Lepiota armillarioides*, 1970, Pegler 1983), Kenya and Tanzania (Pegler 1977), Japan (Hongo 1986), Polynesia and Bolivia (Ovrebo 1988), Mexico (Guzmán-Dávalos & Guzmán 1988), Panamá (Ovrebo unpub. data). Brazil: Rio Grande do Sul (Spegazzini 1889 as *Pleurotus brasiliensis*, Singer 1950, 1953), São Paulo (Pegler 1997), Paraná (De Meijer 2001) and perhaps Mato Grosso and Minas Gerais (Pegler 1990).

Remarks: Although Ovrebo (1988) found slightly broader basidiospores (4.5–5.8 × 3.5–4 (–4.6) µm) and Guzmán-Dávalos & Guzmán (1988) reported spores measuring 4.4–5.6 × 3.6–4 µm, several authors describe basidiospores having a size similar to the northeastern Brazilian *R. brasiliensis* collection. Murrill (1943) described *Lentodium floridanum* Murrill with basidiospores 5 × 3 µm; Singer (1950) reported 4.8–5 × 3.5 µm in his type examination of *Pleurotus brasiliensis* Speg.; Dennis reported 4–5.5 × 2.5–2.72 µm for *Collybia pseudoboryana* Dennis (Dennis 1951) and 5 × 3 µm for *Lepiota armillarioides* (Dennis 1952), a species possibly synonymous with *R. alba* as noted above; and



Figures 9-12: 9-10 Scanning electron microscopy (SEM), basidiospores and basidium of *R. alba*.
11-12 Basidiospores of *R. brasiliensis*. (Photos by Rafael Padilha, LIKA).

Pegler (1983) noted $3.7\text{--}4.5 \times 2.9\text{--}3.5 \mu\text{m}$ for a Caribbean collection of this species.

From Southern Brazil, Rick (1920) recorded *Armillaria rhagadiosa* (Fr.) Quél. (later revised as *R. brasiliensis* by Singer, 1953) with “ $2.5 \mu\text{m}$ ” basidiospores. Pegler (1990), who examined the drawings of several species from Brazil described by Montagne considers *Agaricus exsanguis* and *Marasmius rufopunctatus* Mont. to represent two additional *R. brasiliensis* synonyms.

A related species is *Ripartitella ponderosa* (A.H. Sm. & Singer) Franco-Mol., recently referred by Justo & Castro (2003) to *Cystoderma ponderosum* A.H. Sm. & Singer from North America, which differs in the absence of cystidia and the smaller basidiospores [$3.6\text{--}4 (-5) \times 2.7\text{--}3 \mu\text{m}$, according to Franco-Molano 1993].

Recent studies show that the white-rot fungus *R. brasiliensis* (and other lignolytic tropical Basidiomycetes) have large enzymatic activities that decolorize polymeric dyes. This common species, recorded for the first time from Northeast Brazil, has been selected for biotechnological use in pollutant degradation of several complex molecules similar to lignin molecules (Okino et al. 2000).

Acknowledgements

The senior author is grateful to Dr. Roy E. Halling for species confirmation and suggestions, Dr. Clark L. Ovrebo and Dr. Laura Guzmán-Dávalos for reviewing the manuscript, Dr. Gastón Guzmán for sent literature and Dr. Leonor C. Maia, Ms.C. Elisandro Ricardo Drechsler-Santos and Mr. Bruno T. Goto for help and support. Dr. José Luiz de Lima Filho of the 'Laboratório de Imunologia Keiso Asami' (LIKA) is acknowledged for authorizing the use of the laboratory and Mr. Rafael Padilha (LIKA) for preparing the material for SEM observation. Dr. Lorelei Norvell is acknowledged for editorial suggestions. Thanks also to CNPq for financial support.

Literature cited

- Bandala VM, Montoya L, Jarvio D. 2005. Agarics from coffee plantations in Eastern Mexico: two new records. *Fungal Diversity* 20: 17-29.
- Dennis RWG. 1951. Some *Agaricaceae* of Trinidad and Venezuela. *Leucosporae*. Part I. *Trans. Br. Mycol. Soc.* 34: 411-482.
- Dennis RWG. 1952. *Lepiota* and allied genera in Trinidad, British West Indies. *Kew Bull.* 7: 459-499.
- Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. *Kew Bull. Add. Ser.* 3: 1-541.
- Franco-Molano AE. 1993. Studies on *Cystoderma*: a new species and a new combination. *Mycologia* 85: 672-676.
- Guzmán-Dávalos L, Guzmán G. 1988. Primer registro de *Ripartitella brasiliensis* (Fungi, *Agaricales*) en México. *Acta Bot. Mex.* 4: 9-13.
- Halling RE, Franco-Molano AE. 1996. *Agaricales* from Costa Rica: new taxa with ornamented spores. *Mycologia* 88: 666-670.
- Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. *Ainsworth & Bisby's Dictionary of the Fungi*. 8th Ed. CAB International, Wallingford.
- Hongo T. 1986. On the *Agaricaceae* of Japan. *Trans. Mycol. Soc. Japan* 27: 99-107.
- Johnson J, Vilgalys R. 1998. Phylogenetic systematics of *Lepiota* sensu lato based on nuclear large subunit rDNA evidence. *Mycologia* 90: 971-979.
- Justo A, Castro ML. 2003. *Cystoderma freirei*, une nouvelle espèce découverte en Galice (Espagne). *Cryptog. Mycol.* 24: 309-316.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. *Ainsworth & Bisby's Dictionary of the Fungi*. 9th ed. CAB International, Wallingford.
- Maerz AJ, Paul MR. 1950. *A Dictionary of Color*. 2nd ed., McGraw-Hill Book Company, Inc., New York.
- Matheus DR, Bononi VLR, Machado KMG. 2000. Biodegradation of hexachlorobenzene by basidiomycetes in soil contaminated with industrial residues. *World. J. Microbiol. Biotechnol.* 16: 415-421.
- De Meijer AAR. 2001. Mycological work in the Brazilian state of Paraná. *Nova Hedwigia* 72: 105-159.
- Moncalvo J-M, Lutzoni FM, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationship of agaric fungi based on nuclear large subunit ribosomal DNA sequences. *Syst. Biol.* 49: 278-305.
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller Jr. OK. 2002. One hundred and seventeen clades of euagarics. *Mol. Phylogen. Evol.* 23: 357-400.

- Murrill WA. 1943. Some southern novelties. *Mycologia* 35: 422-433.
- Okino LK, Machado KMG, Fabris C, Bononi VLR. 2000. Ligninolytic activity of tropical rainforest basidiomycetes. *World J. Microbiol. Biotechnol.* 16: 889-893.
- Ovrebo CL. 1988. Notes on the cultural characters, morphology and distribution of *Ripartitella brasiliensis*. *Mycotaxon* 31: 229-237.
- Pegler DN. 1977. A preliminary Agaric flora of East Africa. *Kew Bull. Add. Ser.* 6: 1-615
- Pegler DN. 1983. Agaric Flora of the Lesser Antilles. *Kew Bull. Add. Ser.* 9: 1-668
- Pegler DN. 1990. *Agaricales* of Brazil described by J.P.E.C. Montagne. *Kew Bull.* 45: 161-177.
- Pegler DN. 1997. The Agarics of São Paulo, Brazil. Royal Botanical Gardens, Kew.
- Rick J. 1920. Contributio III ad Monographiam Agaricacinarum Brasiliensium. *Brotéria Ser. Bot.* 18: 48-63.
- Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente (SECTMA). 2001. Diagnóstico das Reservas Ecológicas: Região Metropolitana do Recife. Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente do Estado de Pernambuco, Recife.
- Singer R. 1947. New genera of fungi. III. *Mycologia* 39: 77-89.
- Singer R. 1950. Type studies on *Basidiomycetes*. IV. *Lilloa* 23: 147-246.
- Singer R. 1953. Type studies on *Basidiomycetes* VI. *Lilloa* 26: 57-159.
- Singer R. 1986. *The Agaricales in Modern Taxonomy*. 4th ed. Koeltz Scientific Books, Stuttgart.
- Spegazzini C. 1889. Fungi Puigariani. *Bol. Acad. Nac. Ciências Córdoba* 11: 381-414.

Two rare corticioid species with globose spores

MARÍA NATIVIDAD BLANCO, G. MORENO & J. CHECA

natividad.blanco@uah.es

Dpto. de Biología Vegetal, Universidad de Alcalá
E-28871 Alcalá de Henares, Madrid, Spain

Abstract — Two rare corticioid species with resupinate and arachnoid basidiocarps are compared. These species are similar morphologically but differ in nutritional behaviour: *Botryobasidium globosiporum* is a saprotroph while *Thanatephorus ochraceus* is an endomycorrhizal fungus. Although they differ phylogenetically, they share some microscopic characteristics that occasionally make their determination difficult. Similarities and differences between the two species are discussed and photographs comparing morphological and anatomical characters are provided.

Key words — *Cejpomyces*, *Basidiomycota*, taxonomy

Introduction

The genus *Thanatephorus* was described by Donk (1956) with the following Latin diagnosis:

“Parasiticus. Mycelium formans statum *Rhizoctoniae* consistens e fibrillis vel funiculis et (plerumque) sclerotiis. Fructificatio plus minusve similis *Botryobasidio* sensu stricto natura et structura sed hyphae ascendentes basidiferentes saepe minus evolventes. Basidia brevia et compacta, subcylindrica ad obovoidea, paulum latiora hyphis sustinentibus; sterigmata relative magna, 2-4(-5). Sporae renovantes. Status imperfectus conidiferus ignotus.”

The genus was characterized by its loosely attached resupinate basidiocarps, hyphae branching at right angles, clavate basidia arrayed in a palisade and the production of spore secondaries by proliferation.

The genus *Thanatephorus* includes currently 11 species (Roberts 1999b, Kirk & al. 2001) with *T. cucumeris* (A.B. Frank) Donk (anamorph *Rhizoctonia solani* J.G. Kühn) as type species. *T. cucumeris* is a parasite of various herbaceous plants and produces important agriculture damage depending on the strain virulence (Carling & al. 2002).

In the present paper, we describe *Thanatephorus ochraceus*, an endomycorrhizal species of the family *Orchidaceae*, collected on Mediterranean vegetation in the Natural Park of Cabañeros (Ciudad Real, Spain). Plants within

the well-conserved forest include *Quercus ilex* subsp. *ballota* (Desf.) Samp., *Q. faginea* subsp. *broteroi* (Coutinho) A. Camus, *Q. suber* L., *Q. pyrenaica* Willd., *Alnus glutinosa* (L.) Gaertn., *Pinus pinaster* Aiton with *Cistus ladanifer* L., *Phillyrea angustifolia* L., *Arbutus unedo* L., *Erica arborea* L. and *E. australis* L.

Material and methods

The material of *Thanatephorus ochraceus* was collected during one of several forays during the autumn of 2003. The type material of *Coniophora ochracea* is lost (Roberts 1999a,b); therefore we compared our Spanish specimens with two collections from Italy and Germany deposited in K (M) and with the Spanish specimens cited previously as *Uthatabasidium ochraceum* (Dueñas 1991, 1993) and deposited in MA Fungi and BIO-Fungi. Our research determined that the latter specimens represent *Ceratobasidium cornigerum* (Bourdot) D.P. Rogers, as a result of our revision.

We also compared our specimens to the type of *Botryobasidium globosporum* deposited in LY, a rare species that is microscopically similar to *T. ochraceus* and which has been collected only once in Gabon (Africa).

The collections were studied with a binocular microscope after mounting in KOH 5%, Melzer's reagent and ammoniacal Congo red 5% solution. Spore measurements were made using the oil immersion objective. The micrographs have been made with a Nikon (Eclipse 80i) microscope and a digital camera Nikon (DS-5M).

Taxonomy

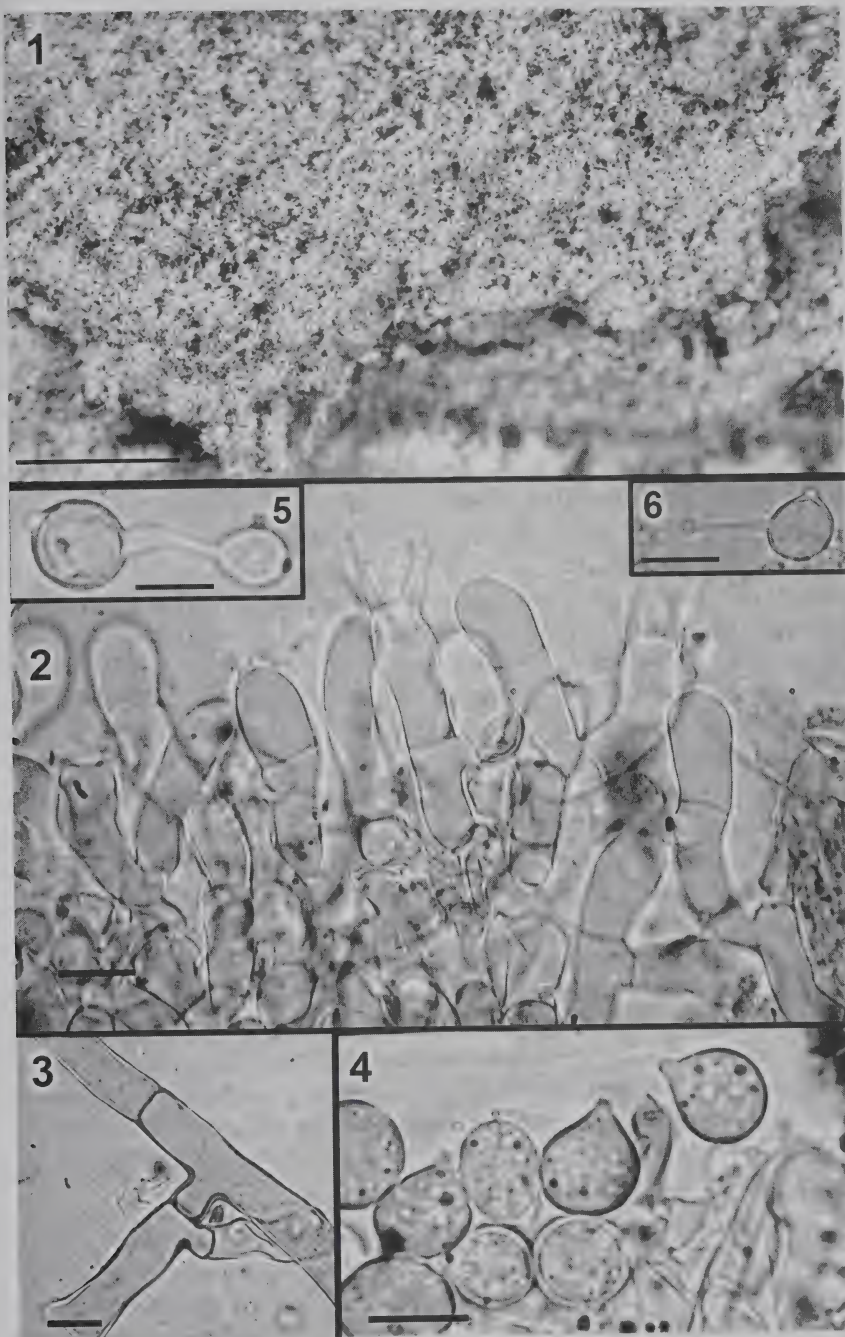
Thanatephorus ochraceus (Masse) P. Roberts, Sydowia 50(2): 252 (1998)

FIGURES 1-6

- = *Coniophora ochracea* Masse, J. Linn. Soc., Bot. 25: 137 (1889)
- = *Botryobasidium ochraceum* (Masse) Donk, Univ. Iowa Stud. Nat. Hist. 17(1): 16 (1935)
- = *Uthatabasidium ochraceum* (Masse) Donk, Fungus, Wageningen 28: 23 (1958)
- = *Corticium frustulosum* Bres., Annls mycol. 1(2): 98 (1903)
- = *Thanatephorus orchidicola* Warcup & P.H.B. Talbot, Trans. Br. mycol. Soc. 49(3): 432 (1966)
- = *Thanatephorus pennatus* Currah, Can. J. Bot. 65: 1958 (1987)

Basidiome arachnoid to hypochnoid, white greyish to light grey. The material from Cabañeros is abundant and very well sporulated. Found growing on five samples of woody debris.

Hyphal system monomitic, without clamps, **subicular hyphae** yellowish, thick-walled, 9-13(-15) µm diam., branching at right angles, **subhymenial hyphae**



thin-walled, 6-9 μm diam. **Basidia** short cylindrical (10-)14-25 x (7-) 9-10 μm , 4-sterigmata 10-13(-20) μm long. **Spores** 7-10 x 6-9 μm , subglobose, hyaline to light yellowish, thick-walled, non-amyloid, non-dextrinoid, cyanophilous, producing secondary spores by repetition. **Cystidia** lacking.

SPECIMENS EXAMINED— **SPAIN:** Ciudad Real, NATIONAL PARK OF CABAÑEROS, ARROYO BREZOSO, 30S 0383-4357 leg. M.N. Blanco, J. Checa & G. Moreno, 8.XI.2003, on debris wood of *Quercus pyrenaica*, AH 31816. Toledo, LA IGLESUELA, 30TUK5256, leg. M. Dueñas, 20.X.1987, MA-FUNGI 23000 (not MA-Fungi 24351, as it appears in Dueñas 1991) [det. M. Dueñas as *Uthatabasidium ochraceum* is *Ceratobasidium cornigerum*]. (in Dueñas 1991, 1993). Alava, RIBERA ALTA, from 2 Km to Subijana, slope W-SW of the Mountain Otero 30TWN0942, 750m, on *Juniperus communis*, leg. Isabel Salcedo & grupo 111, 17.V.1987, 35551S in 31523 BIO-Fungi [det. I. Salcedo as *Uthatabasidium ochraceum* is *Ceratobasidium cornigerum*]. Madrid, VALDELATAS, 30TVK4287, leg. M. Dueñas, 22.X.1993, on *Pinus halepensis*, MA-FUNGI 41417, [det. M. Dueñas as *Uthatabasidium ochraceum* is *Ceratobasidium cornigerum*]. ARGANDA, DEHESA DE ARGANDA, 30TVK6360, leg. M. Dueñas, 19.X.1993, on *Pinus halepensis*, MA-FUNGI 41422, 41416 [det. M. Dueñas as *Uthatabasidium ochraceum* is *Ceratobasidium cornigerum*]. **ITALY:** Puglia, APULIA, on *Cistus monspeliensis* L. (as *C. monspesulensis*), leg. R.W.G. Dennis, 31.X.1981, K (M) 15658. **GERMANY:** Westphalia, WESTFALEN, , on *Quercus* sp., leg. W. Brinkmann, Aut 1907, K(M) 30008.

Comments — *Thanatephorus ochraceus* is characterized by its loosely attached resupinate basidiocarps, yellowish subicular hyphae that branch at right angles, the subglobose spores (7-10 x 6-9 μm), and the production of secondary spores by repetition. The fact that this secondary spore proliferation is sometimes difficult to see sometimes can cause confusion in the determination.

The genus *Uthatabasidium* Donk was described the same year, journal and page as *Thanatephorus* (Donk 1956) and later was synonymized under *Thanatephorus* (Jülich 1984). Roberts (1999a), who studied the type collections of *Thanatephorus orchidicola* (Warcup & Talbot 1966) and *Thanatephorus pennatus* (Currah 1987), synonymized them with *Coniophora ochracea*. Roberts proposed the combination *Thanatephorus ochraceus*, which is accepted here.

The anamorph of *Thanatephorus ochraceus* corresponds to the genus *Rhizoctonia*, which has occasionally been isolated from the roots of orchids, *Orchis mascula* (L.) L., *Coeloglossum viride* (L.) Hartm. (Warcup & Talbot 1966) and *Calypso bulbosa* (L.) Oakes (Currah 1987), forming endomycorrhizal structures. The peculiarity of this substrate should be considered for inclusion of *T. ochraceus* to the European Red Checklist., The teleomorph also grows as a saprophyte on various woody substrates (*Alnus*, *Cistus*, *Hippophae*, *Picea*, *Populus*, *Quercus*, *Ulmus*).

The specimen from the National Park of Cabañeros (AH 31816) was first cited as *Botryobasidium ochraceum* (Blanco & al. 2006). Once subsequent studies revealed the existence of proliferating secondary spores, the collection was

redetermined as belonging to *Thanatephorus*. However, the presence of such spores is not easy to observe in some collections, and even Hjortstam & al. (1988) did not mention them from Swedish material studied by Eriksson (1958). If proliferating spores are not seen, the specimen may be mis-determined. In this case, the specimen was incorrectly placed in *Botryobasidium*.

Thanatephorus ochraceus generally has a yellowish to brownish basidiome. Consequently, it can be misidentified as *Corticium flavescens* sensu auct., now known as *Thanatephorus fusisporus* (J. Schröt.) Hauerslev & P. Roberts (Langer 1994). The latter can be differentiated by the fusiform to citriform basidiospores (14-17 x 5.5-10 µm).

The yellowish colour of the basidiome is not always present in *T. ochraceus*, so *Thanatephorus orchidicola* has also been described with "albidus vel cervinus" colouration (Warcup & Talbot 1966) and *T. pennatus*, with mycelium "cervineo" in PDA and "cremeum" in CMA (Currah 1987), both species being synonyms of *T. ochraceus*.

The basidiocarps of the material from the National Park of Cabañeros have a white greyish to light grey colour, but the microscopic characteristics agree with the other studied collections.

Botryobasidium globosporum (Boidin & Gilles) G. Langer [as '*globosporum*'],

Bibl. Mycol. 158: 144 (1994)

FIGURES 7-11

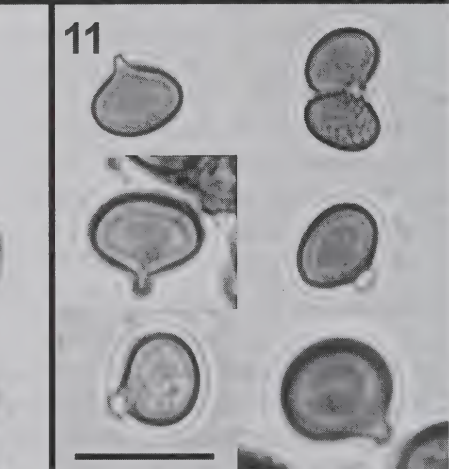
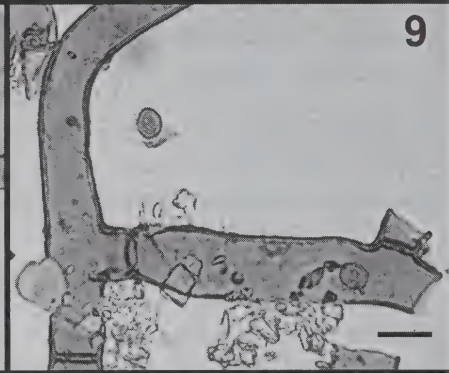
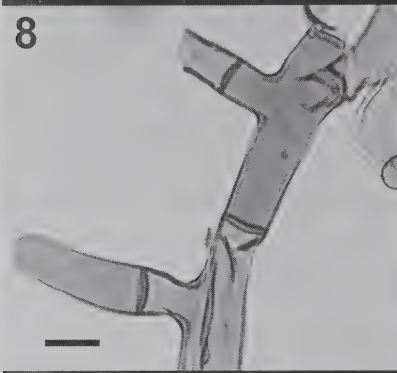
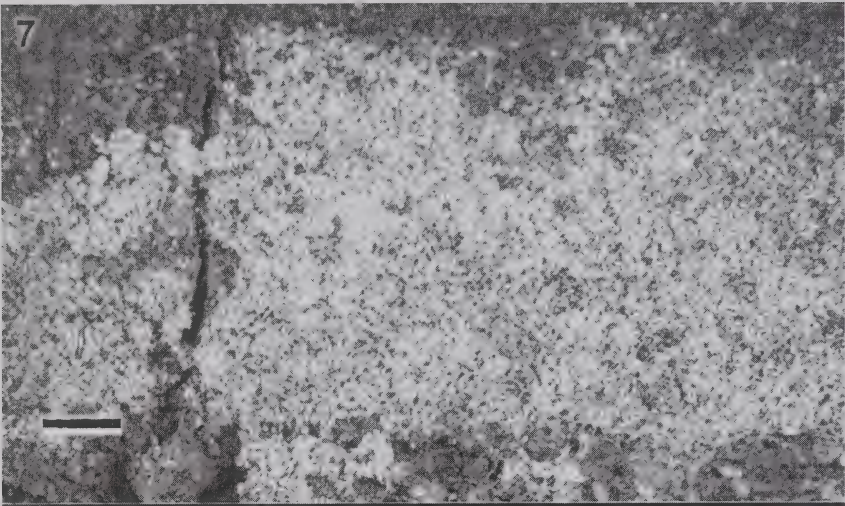
= *Cejpomyces globosporus* Boidin & Gilles [as '*globosporus*'], Mycotaxon 14(1): 289 (1982).

Basidiome archnoid to hypochnoid, fragile, light yellow to light cream and easily separable from the substrate.

Hyphal system monomitic, hyphae without clamps, subicular hyphae well-developed, thick-walled, light yellowish and branched at right angles, 6-10 µm diam., without crystals; **basidia** with 4 sterigmata, difficult to observe and to measure due to the presence of spores; **basidioles** are smaller than the basidia; **spores** 5-7 x 5-6 µm, subglobose to globose in frontal view, with the apex flattened to very obtuse, so their aspect is ellipsoid in side view, hyaline to light yellowish, with thickened walls, non-amyloid, cyanophilous, apiculus very prominent up to 1 µm long; **cystidia** lacking.

SPECIMENS EXAMINED — GABON, LIBREVILLE km. 13 N, littoral bush vegetation, dead wood, 5.XI.1978, leg. G. Gilles 1264, LY 8964 (HOLOTYPE).

Comments. We have studied two envelopes labelled as "Holotypus" with the test cited above. One sample contains instructions on the "utilization of spore-print on plastic slides" written by J. Boidin, one spore-print with the numbers G1264 and 8964 and a wrapper with green paper inside bearing fragmented material. The other envelope contains a piece of wood with a well-developed fungus.



The genus *Cejpomyces* Svrček & Pouzar is typified by *C. terrigenus* (Bres.) Svrček & Pouzar, with smooth spores, 4-sterigmate large basidia arranged in a rather dense palisade and a dense subhymenium formed by short cells. This makes the genus intermediate between *Botryohypochnus*, with strongly ornamented spores and basidia with 4 sterigmata, and *Botryobasidium* with smooth or lightly ornamented spores and basidia with (4-) 6-8 sterigmata. None of the species in these genera produce secondary spores by repetition.

Boidin & Gilles (1982) described a second species, *Cejpomyces globosisporus*, characterized by its globose spores.

Langer (1994) combined the species of *Cejpomyces*: *C. globosisporus* in *Botryobasidium*, and the type species, *C. terrigenus*, in *Thanatephorus*, characterized by the presence of spores secondaries by repetition. This taxonomic treatment is accepted by Kirk & al. (2001) and here.

Discussion

Thanatephorus ochraceus can be confused with *Botryobasidium globosisporum* due to the arachnoid to hypochnoid basidiome. The two species are differentiated by the production of spores secondaries by repetition in *T. ochraceus* and by the following characteristics:

TABLE 1: Character comparisons between *Botryobasidium globosisporum* and *Thanatephorus ochraceus*.

Character	<i>Botryobasidium globosisporum</i>	<i>Thanatephorus ochraceus</i>
Sterigma length	7-8 µm (Boidin & Gilles 1982) 5-8 µm (Langer 1994)	10-13(-20) µm
Spore size	5-6 x 4.5-5.5 µm side view; 5-6 x 5.5-7 µm face view (Boidin & Gilles 1982); 5-6.5 x 4-5.5 µm (Langer 1994)	7-10 x 6-9 µm
Spore repetition	Absent	Present, sometimes difficult to observe
Spore morphology	Subsphaerical, very large flattened (Boidin & Gilles 1982). Subglobose (Langer 1994).	Subglobose
Distribution	Libreville, Gabon, Africa	Europe (several countries)

FIGURES 7-11. *Botryobasidium globosisporum* (LY 8964 HOLOTYPE). 7 - Basidiome. 8-9 - Subicular hyphae. 10 - Hymenium. 11 - Spores.

Scale bars. 7 = 1 mm. 8-11 = 10 µm

Two other genera closely related to *Thanatephorus* are *Ceratobasidium* D.P. Rogers and *Botryobasidium* Donk. *Ceratobasidium* is differentiated by rounded basidia and a hymenium that does not form a dense palisade. *Botryobasidium* does not have spores secondaries by repetition. The genera *Uthatabasidium*, *Ypsilonidum* Donk and *Cejpomyces* are now considered to be synonyms of *Thanatephorus* (Kirk & al. 2001).

Langer (1994) includes in *Botryobasidium* species with a smooth resupinate basidiome, a monomitic hyphal system with hyphae branching at right-angles; basidia arranged in clusters or a dense palisade with 4-8 sterigmata and non-amylloid spores and without spores secondaries by repetition.

Acknowledgements

We wish to express our gratitude to Dr. Javier Rejos, curator of AH, who assisted us in the search of the type collections and to Laura Yebes and David Mitchell for linguistic assistance of the manuscript. A special thanks to Dr. L. Ryvarden and M. Bondartseva for the revision of the manuscript and M.T. Tellería by her taxonomic comments. This research has been supported by the Spanish Project REN2002-01965 and Project 2004X802 "Flora Micológica de Castilla-La Mancha".

Literature cited

- Blanco MN, Moreno G, Checa J. 2006. Adiciones al estudio de los *Polyporales* s. lato del Parque Nacional de Cabañeros. I. Bol. Soc. Micol. Madrid 30: 185-197.
- Boidin J, Gilles G. 1982. *Basidiomycetes Botryohypochoideoae* du Gabon. Mycotaxon 14 (1): 280-304.
- Carling DE, Baird R, Gitaitis RD, Brainard KA, Kunigaga S. 2002. Characterization of AG-13, a newly reported anastomosis group of *Rhizoctonia solani*. Phytopathology 92: 893-899.
- Currah RS. 1987. *Thanatephorus pennatus* sp. nov. isolated from mycorrhizal roots of *Calypso bulbosa* (Orchidaceae) from Alberta. Can. J. Bot. 65: 1957-1960.
- Donk MA. 1956. Notes on resupinate *Hymenomyces* II. The tulasnelloid fungi. Reinwardtia 3: 363-379.
- Eriksson J. 1958. Studies in the heterobasidiomycetes and homobasidiomycetes — *Aphylllophorales* of Muddus National Park in North Sweden. Symb. Bot. Upsal. 16: 1-172.
- Eriksson J, Ryvarden L. 1973. The *Corticiaceae* of North Europe. Vol. 2. Fungiflora. Oslo.
- Hjortstam H, Larsson KH, Ryvarden L. 1988. The *Corticiaceae* of North Europe. vol. 8: 1450-1631. Fungiflora. Oslo.
- Jülich W. 1984. Die Nichtblätterpilze, Gallertpilze und Bauchpilze. In: Kleine Kryptogamenflora II b/1. Stuttgart. New York. 626 pp.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's. Dictionary of the Fungi ninth edit. CAB International. UK. 655 pp.
- Langer G. 1994. Die Gattung *Botryobasidium* Donk (*Corticiaceae*, *Basidiomycetes*). Biblioth. Mycol. 158:1-459.
- Moreno G, Galán R, Llarandi E, Raitvir A. 2004. Estudio de los hongos que fructifican en el Parque Nacional de Cabañeros (Ciudad Real). Bol. Soc. Micol. Madrid 28: 229-269.

- Roberts P. 1999a. *Thanatephorus ochraceus*: a saprotrophic and orchid endomycorrhizal species. *Sydowia* 50: 252-256.
- Roberts P. 1999b. *Rhizoctonia*-forming fungi. A taxonomic guide. The Herbarium. Royal Botanic Gardens. Kew. 239 pp.
- Telleria MT, Melo I. 1995. *Aphylophorales* resupinatae non poroides, I. *Acanthobasidium-Cystostereum*. *Flora Mycologica Iberica*. Vol. 1. Ed. Real Jardín Botánico de Madrid & J. Cramer. 223 pp
- Warcup JH, Talbot PHB. 1966. Perfect states of some *Rhizoctonia*. *Trans. Brit. Mycol. Soc.* 49: 427-435.

Type studies on *Chamaeota* species described from China

ZHU L. YANG

*fungi@mail.kib.ac.cn, fungiamanita@gmail.com**Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany,
Chinese Academy of Sciences, Kunming 650204, Yunnan, China*

Abstract—A critical restudy of the holotype of *Chamaeota dextrinoidespora*, and the holotype and paratypes of *Chamaeota sinica* showed that they belong to *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae* and should be placed in the genus *Leucoagaricus*. Thus, two new combinations, *Leucoagaricus dextrinoidesporus*, and *L. sinicus*, are made. Both species are redescribed and illustrated in detail.

Key words—*Pluteaceae*, *Basidiomycota*, taxonomy

Introduction

The genus *Chamaeota* (W.G. Sm.) Earle, typified by *C. xanthogramma* (Ces.) Earle, is classified in the family *Pluteaceae* Kotl. & Pouzar because of pink and non-dextrinoid basidiospores without a germ pore, free lamellae, a convergent lamellar trama and presence of annulus (Singer 1986). Recent study showed that *C. mammillata* (Longyear) Murrill is an annulate *Pluteus* Fr., and *Chamaeota* may be rendered obsolete (Minnis et al. 2006). During a study of collections of *Agaricaceae* from China, the author found that it is necessary to restudy the types of *C. dextrinoidespora* and *C. sinica*, and the additional materials cited by the authors (Bi & Li 1988, Ying 1995) because these two species might be lepiotaceous fungi. Reexamination of the collections revealed, surprisingly, that (with one exception) they are representatives of *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae*, and should best be placed in the genus *Leucoagaricus* in accordance with the recent taxonomy of this group of fungi.

Materials and methods

The macroscopical descriptions are based on the original descriptions and notes with the material. In the original descriptions colour notations were used by Ying (1995) but not by (Bi & Li 1988). Revived tissues were mounted in 5% aqueous KOH, Melzer's reagent, 1% aqueous Congo red, 1% aqueous Cresyl Blue or cotton blue for microscopic examination. The abbreviation [*n/m/p*]

shall mean n basidiospores measured from m basidiocarps of p collections. Dimensions of basidiospores excluding the apiculus are given using notation of the form $(a) b-c (d)$. The range $b-c$ contains a minimum of 90% of the measured values. Extreme values a and d are given in parentheses. Q refers to the length/width ratio of basidiospores; Q refers to the average Q of all basidiospores $\pm$ sample standard deviation. Herbarium abbreviations follow Holmgren et al. (1990).

Taxonomy

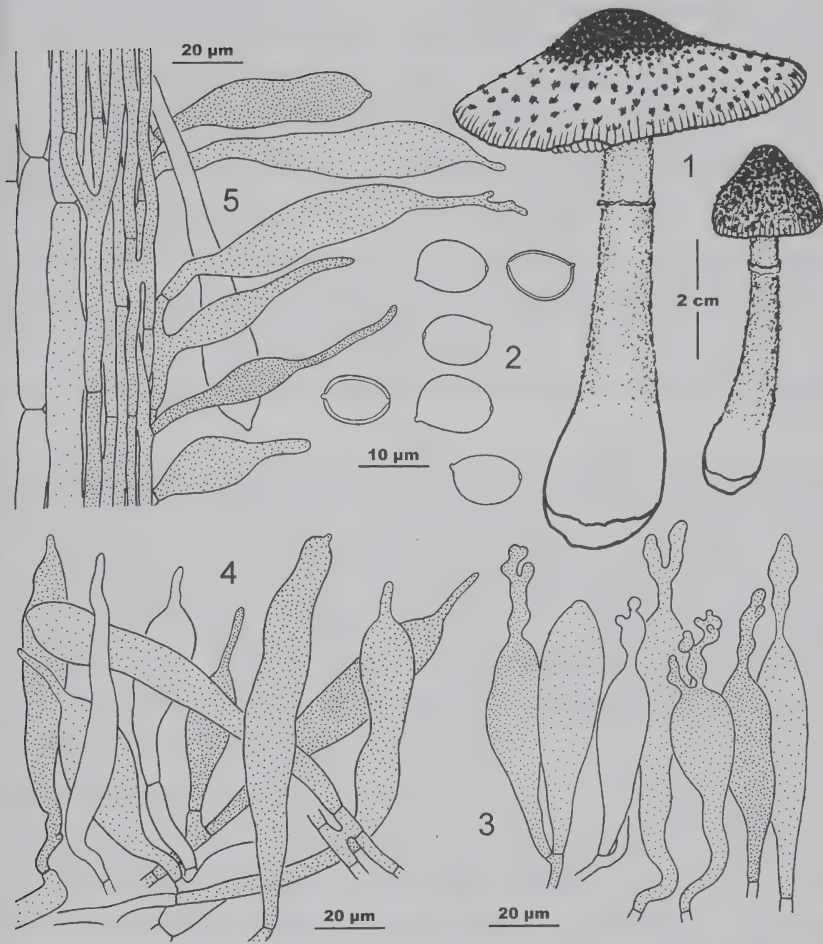
Leucoagaricus dextrinoidesporus (Z.S. Bi) Zhu L. Yang, **comb. nov.** Figs. 1-5

MYCOBANK MB 510604

Basionym: *Chamaeota dextrinoidespora* Z.S. Bi, Bull. Bot. Res. 8 (1): 98, figs. 1-5 (1988).

Basidiomata (fig. 1) scattered. **Pileus** 2-6 cm diam., convex, umbonate, red-brown, becoming umbrinous over disc, covered with minute, brown squamules; margin of pileus finely striate (0.1-0.2R); context concolorous with pileal surface, 2-3 mm thick. **Lamellae** free, cream when young, purple red when mature, becoming dark brown with olivaceous tinge when dried, moderately crowded. **Stipe** 5-8 $\times$ 0.5-1.5 cm, attenuate upwards, becoming hollow when mature; surface brownish to pale red-brown, covered with squamules; base enlarged. **Annulus** superior, membranous, simple, concolorous with the pileus, persistent. Odor and taste none.

Basidiospores (fig. 2) [46/2/1] (8.0) 8.5-11.5 (12.0) $\times$ (6.0) 6.5-8.5 μ m [$Q = (1.25) 1.27-1.36 (1.41)$, $Q = 1.32 \pm 0.03$], in side view broadly ellipsoid to ellipsoid, sometimes slightly amygdaliform, without suprahilar depression, in frontal view ellipsoid to broadly ellipsoid, hyaline, colorless or pale greenish yellow in 5% KOH, strongly dextrinoid, thick-walled (wall up to 1 μ m thick), with germ pore, not or only slightly truncate, without a cap over the pore, cyanophilous, with pink inner wall and pink plug in germ pore in Cresyl Blue (metachromatic). **Basidia** 21-30 $\times$ 9-12 μ m, subclavate, hyaline, thin-walled, 4-spored, not surrounded by pseudoparaphyses; sterigmata 3-4 μ m long; basal clamp connections absent. **Pleurocystidia** absent. **Cheilocystidia** (fig. 3) crowded, often forming a sterile band along the lamellar edge, clavate to fusiform (60-120 $\times$ 13-18 μ m), occasionally broadly clavate (50-70 $\times$ 11-18 μ m), often with a single or a few abrupt, apical, often branched, sinuous to moniliform, appendix up to 30 μ m long and 2-8 μ m in diam, thin-walled, often with a brownish to brownish yellow intracellular pigment in KOH. **Lamellar trama** difficult to rehydrate, probably trabecular, made up of filamentous hyphae 3-12 μ m in diam. **Squamules on pileus** (fig. 4) a disrupted trichodermium composed of loose fascicles of more or less erect, narrowly clavate to subfusiform, sometimes lanceolate, 60-140 $\times$ (8) 13-20 μ m, slightly thick-walled (wall up to 0.5 μ m thick) terminal elements often with yellowish



Figs. 1-5: *Leucoagaricus dextrinoidesporus* (holotype). 1. Basidiomata (based on dry material); 2. Basidiospores; 3. Cheilocystidia; 4. Squamules on pileus; 5. Caulocystidia and surface of stipe.

to brownish intracellular pigment in KOH, sometimes subhyaline and nearly colorless; terminal elements often with abrupt subcylindrical apical appendix up to 10 (30) μm long and 2-5 μm in diam. **Caulocystidia** (fig. 5) densely covering the surface of the stipe except the apical part, clavate to fusiform (55-140 $\times$ 10-20 μm), often with yellowish to brownish, intracellular pigment, slightly thick-walled (wall $\leq 0.5 \mu\text{m}$ thick), often with abrupt subcylindrical apical appendix up to 20 (45) μm long. **Clamp connections** not observed.

Habit, habitat, distribution and season—Scattered, on soil among grass; so far only known from the type locality in Guangdong Province of China; August.

COLLECTION EXAMINED—China, GUANGDONG PROVINCE, Shixing ("Shizing") County, Zhangdong, 20.VIII.1985, Z.S. Bi & Y.F. Liu *s.n.* (GDGM 9701, holotype).

Comments—In the above description the color and size of the basidiomata are mainly based on the data of Bi & Li (1988) and notes with the holotype. Other data are from personal observations on the dried holotype material. Bi & Li (1988) stated that the basidiospores of the present species were pale purple-red and without a germ pore, and clamp connections were present. This does not seem to be the case. The color changes of the basidioma on bruising or cutting and the reaction of the lamellae and the context to ammonia vapor are unknown, and need to be studied in the future when fresh material becomes available.

Due to the trichodermial elements in the squamules on the pileus and the hyaline, colorless, dextrinoid and metachromatic basidiospores with a germ pore, this taxon is not a species of *Chamaeota* but belongs to the *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae* (fide Vellinga 2004). It should be placed in *Leucoagaricus* Singer (fide Vellinga 2000, 2001, 2004, Vellinga & Davis 2007), and is very close to *L. americanus* (Peck) Vellinga (= *L. bresadolae* (Schulzer) Bon), *L. holospilotus* (Berk. & Broome) Bon and *L. meleagris* (Sowerby) Singer. However, *L. americanus* usually has larger basidiomata with all parts becoming yellow or saffron and finally red-brown on bruising, and slender, tapering elements in the squamules on the pileus [Smith & Weber 1987 under *Lepiota americana* (Peck) Sacc., Reid 1999, Vellinga 2000, 2001]. *Leucoagaricus holospilotus*, originally described from Sri Lanka, differs from *L. dextrinoidesporus* by its somewhat smaller basidiospores, shorter appendix of cheilocystidia and smaller terminal elements in the squamules on the pileus (Reid 1990 under *Leucocoprinus holospilotus* (Berk. & Broome) D.A. Reid, Pegler 1972, 1986 under *Lepiota holospilota* (Berk. & Broome) Sacc.). *Leucoagaricus meleagris* has a pileus with dark brown to blackish squamules, a context becoming yellow and then red on exposure, cheilocystidia with shorter apical appendix, and clavate fusoid to lanceolate elements in the squamules on the pileus often without an abrupt subcylindrical apical appendix (Reid 1990, Vellinga 2000, 2001). According to Vellinga (2000), the North American species *Lepiota sanguiflua* Murrill is very close to *L. meleagris* and may well be identical. *Leucoagaricus caldariorum* (D.A. Reid) Bon (= *Leucocoprinus caldariorum* D.A. Reid) (nom. inval., Art. 37.5, herbarium mentioned neither by Reid 1990 nor by Bon 1993) originally described from the UK, is also somewhat similar to *L. dextrinoidesporus* but has a stipe becoming red when scratched, a hymeniform lower layer in the squamules on the pileus (Reid 1990).

Bi & Li (1988) stated that the present species is similar to *Chamaeota tropica* Pegler, but differs from the latter by the color of the pileus and the dextrinoid spores. However, *C. tropica* has a much smaller, buff-yellow pileus with a narrowly plicate striate margin, whitish lamellae with a faint pink tinge, a white stipe, smaller subglobose to lacrymoid basidiospores without a germ pore, and pyriform cheilocystidia. Moreover, the pileipellis is an epithelium of isodiametric elements 8-15 μm in diam. (Pegler 1983).

Bi & Li (1988) cited another collection, GDGM 9175, besides the holotype under the name of *Chamaeota dextrinoidespora*. Reexamination revealed that it is *Chlorophyllum hortense* (Murrill) Vellinga (Ge & Yang 2006).

Leucoagaricus sinicus (J.Z. Ying) Zhu L. Yang, comb. nov.

Figs. 6-10

MYCOBANK MB 510605

Basionym: *Chamaeota sinica* J.Z. Ying, Mycotaxon 54: 303, figs.1-8, 1995.

Basidiomata (fig. 6) caespitose to gregarious. **Pileus** 2.5-6 cm diam., convex, distinctly umbonate, vinaceous-cinnamon, darker over disc, densely covered with minute, dark brown squamules; margin finely striate (0.1-0.3R) or barely striate; context flesh-colored, vinaceous buff on drying. **Lamellae** free, pinkish, becoming dirty white to brownish when dried, moderately crowded to crowded; lamellulae in 2-3 tiers. **Stipe** 4-9 $\times$ 0.3-0.6 cm, subcylindrical or slightly attenuate upwards, hollow; surface concolorous with the pileus, covered with squamules; basal mycelium white to dirty white when dried. **Annulus** superior, membranous, often persistent.

Basidiospores (fig. 7) [60/3/3] 9.0-11.5 (13.0) $\times$ 6.5-8.0 (8.5) μm [$Q = (1.27) 1.35-1.57 (1.71)$, $Q = 1.45 \pm 0.08$], in side view ellipsoid, occasionally slightly amygdaliform, without suprahilar depression, in frontal view ellipsoid to subovoid, hyaline, colorless or pale greenish yellow in 5% KOH, rarely with yellow-brown pigment, thick-walled (wall up to 1 μm thick), with germ pore, not or only slightly truncate, without a cap over the pore, strongly dextrinoid, cyanophilous, with pink inner wall and pink plug in germ pore in Cresyl Blue (metachromatic). **Basidia** 23-35 $\times$ 9-11 μm , subclavate, hyaline, thin-walled, 4-spored, rarely intermixed with 2- or 3-spored basidia, not surrounded by pseudoparaphyses; sterigmata 3-4 μm long; basal clamp connections absent. **Pleurocystidia** absent. **Cheilocystidia** (fig. 8) scattered to crowded, often in fascicles, irregularly cylindrical and sinuous [50-120 (150) $\times$ 3-10 (13) μm], occasionally clavate (40-60 $\times$ 10-13 μm), sometimes with apical part slightly enlarged and irregularly branched, colorless, hyaline or with yellow-brown to ochreous intracellular pigment in KOH, thin-walled, occasionally slightly thick-walled (wall $\leq$ 0.5 μm thick). **Lamellar trama** difficult to rehydrate, probably trabecular, made up of filamentous hyphae 3-10 μm in diam.,

branching, interwoven, sometimes anastomosing. **Squamules on pileus** (fig. 9) a disrupted trichodermium composed of loose fascicles of long, more or less erect, subcylindrical, occasionally narrowly fusiform or lanceolate elements, $70\text{--}170 \times 7\text{--}10$ (14) μm , thin to slightly thick-walled (wall $<0.5\mu\text{m}$ thick), often with a dark brown to dark yellowish brown intracellular pigment. **Caulocystidia** (fig. 10) densely covering the whole surface of the stipe except the apical part, subcylindrical to lanceolate [$50\text{--}150$ (200) $\times$ $5\text{--}16$ (20) μm], sometimes broadly clavate ($30\text{--}70 \times 10\text{--}15$ μm), colorless, hyaline or with a yellow-brown, intracellular pigment, thin- to slightly thick-walled (wall $\leq 0.5\mu\text{m}$ thick). **Clamp connections** not observed.

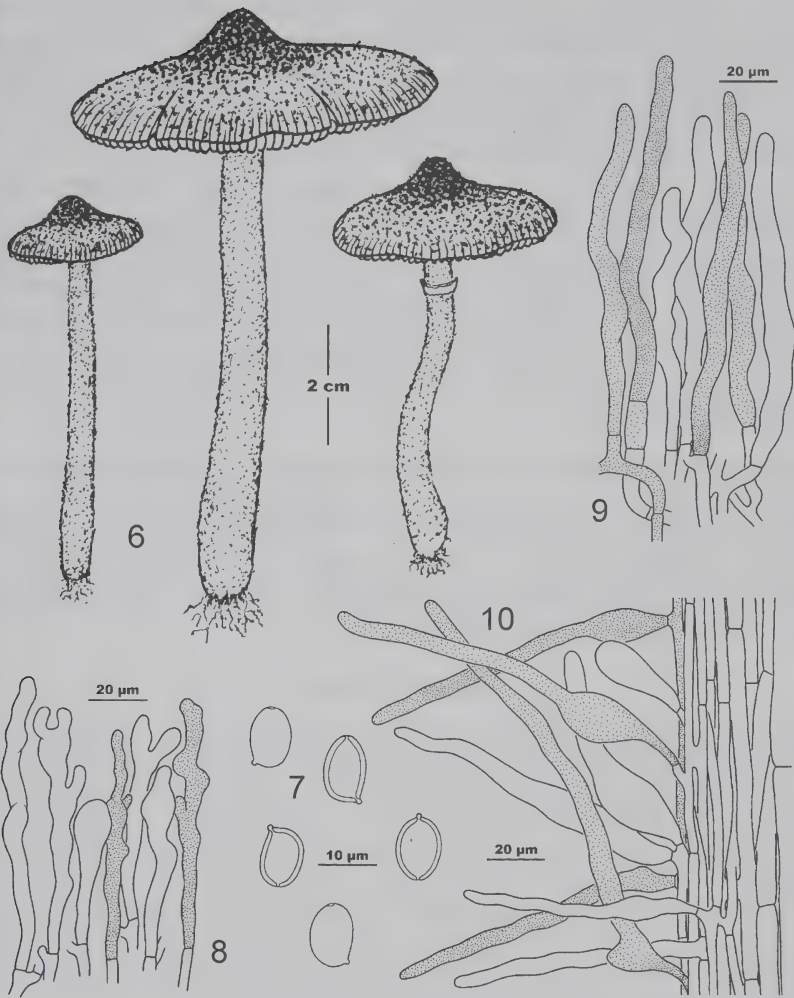
Habit, habitat, distribution and season — Caespitose to gregarious, on soil under bushes of *Rhododendron*; so far only known from the type locality in Zhejiang Province of China; May.

COLLECTIONS EXAMINED—China, ZHEJIANG PROVINCE, HANGZHOU CITY, Jiulisong ($30^{\circ}.16' \text{N}$, $120^{\circ}.10' \text{E}$), 14.V.1990, J.F. Wen 904 (HMAS 59909, paratype); the same location, 15.V.1990, J.F. Wen 905 (HMAS 60647, holotype); the same location, 16.V.1990, J.F. Wen 906 (HMAS 62975, paratype).

Comments—In the above description the color and size of the basidiomata are mainly based on the data of Ying (1995) and notes with the materials. Other data are from personal observations on the dried material cited above. In the protologue, the spore mass, and mycelium at the base of the stipe were described as between Buff-Pink and Japan Rose, and Pale Vinaceous respectively (Ying 1995), which, together with the color changes on bruising or cutting and the reaction of the lamellae and the context to ammonia vapor, need to be studied in the future when fresh material becomes available. Ying (1995) described that the basidia were 2-spored, rarely 4-spored, and cheilocystidia were composed of long, septate cells. The present observations on the specimens cited above differ from those in Ying's report.

Due to the trichodermial elements composing the squamules on the pileus and the hyaline, colorless, dextrinoid and metachromatic basidiospores with a germ pore, this species is not a member of *Chamaeota* but belongs to the *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae* (fide Vellinga 2004). It should be placed in *Leucoagaricus* (fide Vellinga 2000, 2001, 2004, Vellinga & Davis 2007). This species is well characterized by its subcylindrical stipe, irregularly cylindrical to sinuous cheilocystidia with apical part slightly enlarged and irregularly branched, and subcylindrical to narrowly fusiform trichodermial elements in the squamules on the pileus.

Leucoagaricus sinicus is similar to *L. americanus*, and *L. meleagris*. However, *L. sinicus* differs from the latter two by its subcylindrical stipe, the more or less irregularly cylindrical cheilocystidia often with apical branches, and the



Figs. 6-10: *Leucoagaricus sinicus* (holotype). 6. Basidiomata (based on dry material); 7. Basidiospores; 8. Cheilocystidia; 9. Squamules on pileus; 10. Caulocystidia and surface of stipe.

subcylindrical to narrowly fusiform or lanceolate elements without a tapering apex in the squamules on the pileus. Moreover, *L. americanus* usually has larger basidiomata and *L. meleagris* has fibrillose squamules on the pileus and an inconspicuous germ pore on the spore wall (Vellinga 2001). According to Ying (1995), the pileus context of *L. sinicus* is flesh-colored, while that of *L. americanus* and *L. meleagris* is usually white to whitish but changes to yellow, and

then reddish to red after cutting (Vellinga 2000, 2001). Molecular phylogenetic analysis based on ITS and nLSU-rDNA nucleotide sequences of the holotype of *L. sinicus* and other members of the *Leucoagaricus/Leucocoprinus* clade also showed that *L. sinicus* clustered with the *L. americanus* group, but differs from *L. americanus* and *L. meleagris* (unpublished data of Z.W. Ge).

Leucoagaricus sinicus is also somewhat similar to *L. holospilotus* and *L. caldariorum*. However, *L. holospilotus* has smaller basidiospores, clavate to lanceolate cheilocystidia often with an appendix and much wider trichodermial elements in the squamules on the pileus. *Leucoagaricus caldariorum* has broadly amygdaliform, somewhat smaller basidiospores, ovate, clavate to lanceolate cheilocystidia often with a short apical appendix and much wider clavate to lanceolate elements in the squamules on the pileus with a hymeniform lower layer (Reid 1990).

With regard to the more or less cylindrical stipe and elements in the squamules on the pileus, *L. sinicus* is similar to *Leucocoprinus lacrymans* T.K.A. Kumar & Manim. However, the latter differs from *L. sinicus* by its white to whitish pileus and stipe beaded with golden yellow to reddish brown watery exudates, the white to pale orange context, and the somewhat narrower cheilocystidia and caulocystidia (Kumar & Manimohan 2004).

Acknowledgments

The author is very grateful to Prof. Dr. T.H. Li, Guangdong Institute of Microbiology (DGGM), China for allowing him access to the specimens there and for sending him specimens of lepiotaceous fungi on loan, and to Prof. Dr. L. Guo, Institute of Microbiology of the Chinese Academy of Sciences (HMAS) for sending him the holotype and the paratypes of *Chamaeota sinica* on loan. He expresses his sincere gratitude to Dr. E.C. Vellinga, University of California at Berkeley, and Dr. P. Manimohan, University of Calicut, for critically reviewing this paper and for providing some literature. This study was supported by the National Science Fund for Distinguished Young Scholars (No. 30525002) of the National Natural Science Foundation of China, and by the Knowledge Innovation Program of the Chinese Academy of Sciences (KSCX2-YW-G-025).

Literature cited

- Bi ZS, Li TH. 1988. Two new species of agarics from North Guangdong Province of China. *Bulletin of Botanical Research* 8 (1): 97-102.
- Bon M. 1993. *Novitates lepiotarum*. *Documents Mycologiques* 23 (91): 33.
- Ge ZW, Yang ZL. 2006. The genus *Chlorophyllum* (Basidiomycetes) in China. *Mycotaxon* 96: 181-191.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. *Index herbariorum*. Part I: herbaria of the world. 8th edition. New York Botanical Garden: New York (USA). 693 pp.
- Kumar TKA, Manimohan P. 2004. A new species of *Leucocoprinus* from India. *Mycotaxon* 90: 393-397.

- Minnis AM, Sundberg WJ, Methven AS, Sipes SD, Nickrent DL. 2006. Annulate *Pluteus* species, a study of the genus *Chamaeota* in the United States. *Mycotaxon* 96: 31-39.
- Pegler DN. 1972. A revision of the genus *Lepiota* from Ceylon. *Kew Bulletin* 27: 155-202.
- Pegler DN. 1983. Agaric Flora of the Lesser Antilles. *Kew Bulletin Additional Series* 9: 1-668.
- Pegler DN. 1986. Agaric Flora of Sri Lanka. *Kew Bulletin Additional Series* 12: 1-519.
- Reid DA. 1990. The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in ammonia fumes. *Mycological Research* 94: 641-670.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th edit. Koeltz Scientific Books: Koenigstein (Germany). 981 pp.
- Smith HV, Weber NS. 1987. Observations on *Lepiota americana* and some related species. *Contributions from the University of Michigan Herbarium* 16: 211-221.
- Vellinga EC. 2000. Notes on *Lepiota* and *Leucoagaricus*. Type studies on *Lepiota magnispora*, *Lepiota barssii*, and *Agaricus americanus*. *Mycotaxon* 76: 429-438.
- Vellinga EC. 2001. *Leucoagaricus* (Locq.: ex) Sing. In: Noordeloos ME, Kuyper ThW, Vellinga EC. (eds). *Flora Agaricina Neerlandica* 5: 85-108. - A. A. Balkema Publishers: Lisse, Abingdon, Exton (PA) and Tokyo.
- Vellinga EC. 2004. Genera in the family *Agaricaceae*: evidence from nrITS and nrLSU sequences. *Mycological Research* 108: 354-377.
- Vellinga EC, Davis RM. 2007. Lepiotaceous fungi in California, U.S.A.-1. *Leucoagaricus amanitoides* sp. nov. *Mycotaxon* 98:197-204.
- Ying JZ. 1995. New and noteworthy agarics from China I. New species of *Chamaeota*. *Mycotaxon* 54: 303-307.

***Mayamontana coccolobae* (Basidiomycota), a new sequestrate taxon from Belize**

MICHAEL A. CASTELLANO^{1*}, JAMES M. TRAPPE² & D. JEAN LODGE^{3*}

mcastellano@fs.fed.us

¹U. S. Department of Agriculture, Forest Service,
Pacific Northwest Research Station, Forestry Sciences Laboratory
3200 Jefferson Way, Corvallis, Oregon 97331, USA

trappej@onid.orst.edu

²Department of Forest Science, Oregon State University
Corvallis, Oregon 97331-5752, USA

dlodge@fs.fed.us

³U. S. Department of Agriculture, Forest Service,
International Institute of Tropical Forestry
PO Box 1377, Luquillo, Puerto Rico 00773-1377

Abstract—A new semi-hypogeous, sequestrate genus and species in the *Basidiomycota* is described from the Maya Mountains of Belize, where it was fruiting in association with *Coccoloba belizensis*. *Mayamontana coccolobae* is characterized by small, bright orange basidiomata with a friable, loculate, red-orange to red gleba and bilaterally asymmetric, ellipsoid to subglobose, hyaline to pale green or yellow spores with a slightly wrinkled utricle and thick walls.

Keywords: taxonomy, distribution

Introduction

While collecting basidiomycetes in the Maya Mountains of Belize as part of a US National Science Foundation funded project, one of us (DJL) encountered bright orange, semi-hypogeous, sequestrate basidiomes under *Coccoloba belizensis* Standl. (*Polygonaceae*) and other regionally endemic ectomycorrhizal hosts. The red-orange, loculate gleba bore hyaline, asymmetrical ballistospores with a wrinkled utricle, unlike other genera of sequestrate fungi. A new genus and species, *Mayamontana coccolobae*, is described from these collections.

* This paper was prepared by USA Govt. employees on official time, and is therefore in the public domain and not subject to copyright.

Belize is on the southwestern corner of the Yucatan Peninsula, adjacent to México, Guatemala and Honduras and is part of the old terrain of Central America. The upper parts of the Maya Mountains, located in Belize and adjacent parts of Guatemala and Chiapas, México, have remained above sea level as isolated islands during interglacial periods and may have served as refugia for ancestral lineages of various taxa. The basidiomes of the new taxon were primarily associated with the ectomycorrhizal tree, *Coccoloba belizensis* in the Mountain Pine Ridge and Vaca Plateau regions, but also with species of *Neea* (*Nyctaginaceae*) at lower elevations in Blue Hole National Park. The Mountain Pine Ridge near the Five Sisters Falls is granitic, whereas the Vaca Plateau at the Rio Frio Cave Park and the Maya Mountain foothills at Blue Hole National Park are on limestone.

Materials and methods

Methods of collecting and macroscopic and microscopic study were generally those of Castellano et al. (1989). Colors of fresh specimens are in general terms. Hand-cut sections of both fresh and dried material were mounted in water, 5% KOH, Melzer's reagent, or cotton blue for standard light microscopy. Measurements of structures are from mature specimens and, when two dimensions are given, the length precedes the width. Photomicrographs are from material mounted in 5% KOH. Herbaria are abbreviated according to Holmgren et al. (1990). All specimens are deposited in the Mycological Herbarium of Oregon State University (OSC) and also in Forest Department Herbarium, Belize (BRH).

DNA was extracted from basidiome tissue using the CTAB/chloroform method described by Gardes & Bruns (1993), except that the source tissue was not lyophilized. The DNA extract was purified with the Q-Biogene GeneClean II glassmilk kit, and the ITS region of the nrDNA was amplified with primers ITS-1F and ITS-4 using the following PCR protocol: 1) 5 m at 95 C; 2) 1 m at 95 C; 3) 1 m at 52 C; 4) 2 m at 72 C; 5) repeat from step two 34 times. Success of the amplification was checked by electrophoresis on a 2.5% agarose gel.

Successfully amplified PCR product was again cleaned using the Q-Biogene GeneClean II glassmilk kit. Concentration of DNA in the PCR product was estimated by electrophoresing the product on a 2.5% agarose gel with a calibrated marker in an adjacent lane. The purified PCR product was diluted to an approximate molecular weight of 50 ng in 7 µl of dH₂O. To this dilution was added 0.6 µl of primer ITS-4, 1 µl of sequencing buffer, and 2 µl of ABI Prism Big Dye Terminator 3.1. This cocktail was subjected to the following PCR protocol: 1) 5 m at 96 C; 2) 30 s at 96 C; 3) 15 s at 50 C; 4) 4 m at 60 C; 5) repeat from step two 25 times.

Sequencing was performed by the Oregon State University Center for Genome Research and Biocomputing on an Applied Biosystems capillary 3730 Genetic Analyzer. The sequences were submitted to the BLAST search engine for matching at the National Center for Biotechnology Information.

The large subunit of nrDNA of one specimen was also amplified and sequenced. Methods were as above except primers LR0R and LR3 were used for initial PCR amplification and LR0R was used for sequencing. BLAST results (below) were consistent with those for the ITS region.

Taxonomic description

Mayamontana Castellano, Trappe & Lodge, gen. nov.

MYCOBANK MB510440

A Stephanosporaceis altris gleba pallide rubroaurantia vel rubra et sporis bilateraliter asymmetricis, laevibus, utriculo rugoso, pariete crasso, singulatim hyalinis vel pallide viridibus vel luteis, in massa pallide viridiluteis, pedicellatis.

Etymology: *Mayamontana* honors the Mayan people and refers to the Maya Mountains.

Type species: *Mayamontana coccolobae* sp. nov.

Mayamontana coccolobae Castellano, Trappe & Lodge, sp. nov.

Fig. 1

MYCOBANK MB510441

Basidiomata 6–8 mm lata, vivide aurantia. Gleba loculata, friabilis, pallide rubroaurantia vel rubra. Sporae (–9) 10–12 (–14) × (5–) 6.5–7 (–8) μm, bilateraliter asymmetricae, laeves, utriculo parum rugoso, pariete plus minusve 2 μm crasso, singulatim hyalinae vel pallide virides vel luteae, in massa pallide viridilutea, pedicello 3 × 2 μm. Holotypus BZ-1943.

Etymology: *coccolobae* refers to the association of this species with the plant, *Coccoloba belizensis*.

Basidiomata beneath loose litter or exposed, attached to the surface of mineral soil, attachment point evident at base where the peridium does not enclose the gleba, when fresh 6–8 mm in diameter, ovoid, bright orange, slightly felty, as dried 2–3 × 2–5 mm, irregularly flattened, subglobose to globose, pale orange-tan to orange to bright orange, slightly felty, very wrinkled; **gleba** when dried friable, pale red-orange to red, when rehydrated in 5% KOH the mediostratum of the trama is often bright red; spores and hyphae partially filling the irregularly rounded locules, 0.1–0.2 mm broad, red-orange leachate apparent when mounted in 5% KOH; **columella** lacking; **odor** none; **taste** not recorded.

Peridium 100–125 μm thick, of pale orange, thin-walled, inflated cells and irregularly interwoven to subparallel hyphae (5–10 μm in diam); the tissue near the outer surface encrusted with debris; the tissue near the gleba tends

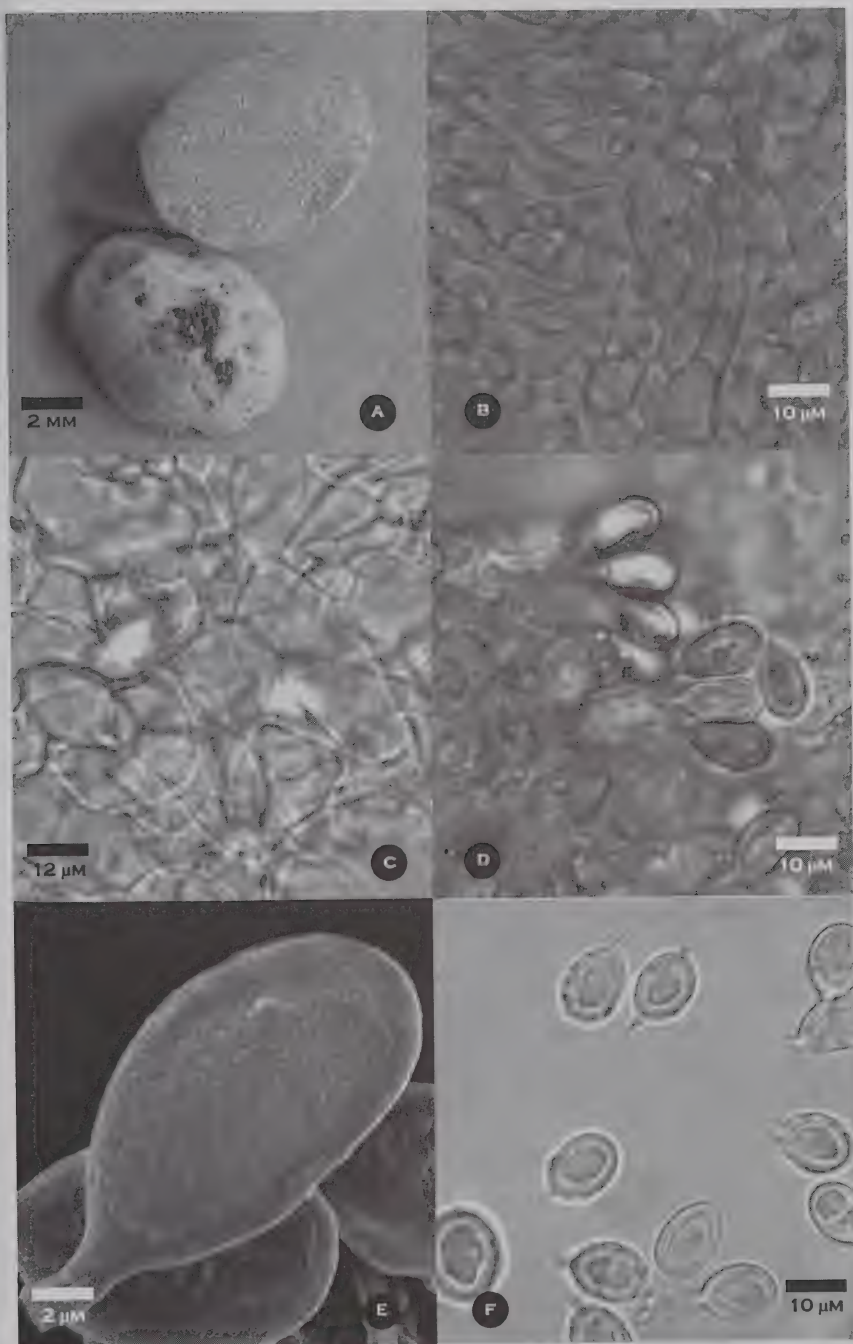
to have more interwoven hyphae than inflated cells, but no clear demarcation of peridial layer boundaries; **trama** similar in structure to the peridium but more pale to nearly hyaline, of thin-walled cells irregularly inflated, up to $17 \times 39 \mu\text{m}$, mostly about $15 \times 20 \mu\text{m}$; **subhymenium** of hyaline, thin-walled, cells irregularly inflated up to 5 mm diam; **hymenium** a palisade of basidia and basidioles, collapsing soon after spore development and obscured by the mass of spores; **cystidia** absent; **basidia** hyaline, thin-walled, subclavate, $25\text{--}37 \times 7\text{--}10 \mu\text{m}$, 4-spored; **sterigmata** $2\text{--}6 \mu\text{m}$ tall, $1\text{--}2 \mu\text{m}$ wide at base, hyaline; **clamp connections** absent; **spores** (9-) $10\text{--}12$ (-14) $\times$ (5-) $6.5\text{--}7$ (-8) μm , asymmetrical, broadly ellipsoid to subglobose, slightly flattened on one side, smooth; utricle uneven, slightly wrinkled, not inflated, giving the spore a roughened to warty appearance, thick walled, up to $\pm 2 \mu\text{m}$ thick; inner surface of the spore wall appearing uneven, in KOH mostly hyaline but sometimes slightly pale green or yellow singly, in mass pale green-yellow, in Melzer's reagent no reaction; spore walls $0.5 \mu\text{m}$ thick; **pedicel** distinct, up to $3 \mu\text{m}$ long and $2 \mu\text{m}$ wide; the end appearing ragged.

Ecology, range, and distribution—Seimi-hypogeous, scattered, on soil under loose leaf litter, beneath *Coccoloba belizensis* and *Neea* sp. at 70–370 m elevation in the Maya Mountains of Belize; August and October.

REPRESENTATIVE SPECIMENS EXAMINED—BELIZE: MAYA MOUNTAINS, MOUNTAIN PINE RIDGE, FOREST RESERVE, FIVE SISTERS LODGE, LOWER NATURE TRAIL ($88^\circ 59' 8'' \text{W } 17^\circ 2' 16'' \text{N}$), D.J. LODGE, BZ-3052, 5.X.2003 (HOLOTYPE-BRH; ISOTYPE-OSC). BELIZE: SAME LOCALITY AS HOLOTYPE EXCEPT, UPPER NATURE TRAIL ($88^\circ 59' 8'' 17^\circ 2' 19.4'' \text{N}$), D.J. LODGE, BZ-74, 10.VIII.2001 (BRH; OSC); BLUE HOLE NATIONAL PARK, MAYA MOUNTAINS, NORTHERN FOOTHILLS, CAVES BRANCH, ALONG HUMMINGBIRD LOOP TRAIL ($88^\circ 41' 1.5'' \text{W } 17^\circ 9' 29.5'' \text{N}$), D.J. LODGE, BZ-1943, 30.X.2002 (BRH; OSC).

Comments—*Mayamontana* is characterized by the small, hyaline, asymmetrical, smooth spores with a roughened utricle and a distinct pedicel, unusual in sequestrate taxa. The spores are similar to those of *Sclerogaster* in overall appearance but are significantly larger in size and lack the distinct warts of *Sclerogaster* spores. Basidiome characters are reminiscent of *Stephanospora* in peridial color, size, texture of the peridium and fruiting habit. We extracted DNA material from *M. coccolobae* and upon performing a BLAST search using GENCOM it is placed in the *Stephanosporaceae* (Martin et al. 2004) near *Stephanospora caroticolor* (Berk.) Pat. (GenBank Accession AJ419224). The characteristics of the basidiome are somewhat similar to species of

Fig. 1. *Mayamontana coccolobae* (holotype). A. Basidioma, B. Peridial hyphae in radial section; C. Tramal cells in radial section; D. Basidia and spores attached to sterigmata; E. SEM of basidiospore with distinct pedicel; F. Light photomicrograph of basidiospores showing the ragged end of the pedicel.



Stephanospora but basidiomes of *Stephanospora* species have a yellow peridium and a gray-olive gleba. *Mayamontana* also differs markedly from all described *Stephanospora* taxa by the lack of a basal ornamental collar or "corona" surrounding the spore base and prominent, wedge-shaped ridges.

Acknowledgements

We thank Matthew Trappe of the Department of Forest Science, Oregon State University, for extracting, amplifying and blasting various DNA components to elucidate genus placement. We thank Drs. Efren Cázares, Roy Halling and Brad Kropp for reviewing the manuscript. This research was supported by a grant from the National Science Foundation, Biodiversity Surveys and Inventories Program to the State University of New York, College at Cortland (DEB-0103621), in collaboration with the Center for Forest Mycology Research, USDA-Forest Service, Forest Products Laboratory. The International Institute of Tropical Forestry, USDA-Forest Service, provided facilities in Puerto Rico for specimen analysis and processing. Ms. Beatriz Ortiz-Santana helped collect specimens. We are especially grateful to Dr. Sharon Matola, Director of the Belize Zoo and Mr. Tony Garel, the former Station Manager of the Tropical Education Center, for assisting with lodging, logistics, and equipment storage. We also thank Carlos Popper and the staff at Five-Sisters Lodge for permission to collect on their property and providing an ideal work environment in the Mountain Pine Ridge. Mrs. Melita Pratt and Mr. Nigel Bouloy of Jabiru Auto Rental assisted with logistics of arrivals and departures in Belize. Mr. Hector Mai assisted in plant identification. Several individuals with government and non-governmental agencies in Belize are acknowledged for their kind help with permits and guidance: Dr. Lizandro Quiroz, Ms. Natalie Rosado, Mr. Hector Mai, Mr. Marcelo Windsor, and Mr. John Pinelo of the Conservation Division, Belize Forestry Department in Belmopan and the Programme for Belize in Belize City.

Literature cited

- Castellano MA, Trappe JM, Maser Z, Maser C. 1989. Keys to Spores of the Genera of Hypogeous Fungi of North Temperate Forests with Special Reference to Animal Mycophagy. Mad River Press, Eureka, California (USA). 186 pp.
- Gardes M, Bruns T. 1993. ITS primers with enhanced specificity for basidiomycetes: applications to the identification of mycorrhizae and rusts. *Molecular Ecology* 2:113-118.
- Holmgren PK, Holmgren NH, Barnett LC. (1990). Index herbariorum. Part I: Herbaria of the World. 8th ed. Bronx, The New York Botanical Garden, Bronx, 693 pp.
- Martin MP, Raidl S, Telleria NT. 2004. Molecular analyses confirm the relationship between *Stephanospora caroticolor* and *Lindtneria trachyspora*. *Mycotaxon* 90:133-140.

***Vittalia indica* gen. & sp. nov. and
Helicoma indicum sp. nov.
from the forests of northeastern India**

PUJA GAWAS ¹ & D.J. BHAT ²

¹pujabg@yahoo.co.in & ²bhatdj@rediffmail.com

Department of Botany, Goa University

Goa-403 206, India

Abstract — Two newly discovered hyphomycetous fungi isolated from forest litter of northeastern India are described in this paper. *Vittalia*, typified by *V. indica*, has solitary, verrucose, euseptate conidia produced on monotretic conidiogenous cells borne on smooth, branched conidiophores. The new species, *Helicoma indicum*, is distinguished from other known species in the genus by its uniseptate conidia.

Key words — *Bharatheeya*, *Diplococcium*, fungal diversity, *Spadicoides*, taxonomy

Introduction

Arunachal Pradesh, Assam, Mizoram and Nagaland, the northeastern Indian States, exhibit a rich and luxuriant floristic diversity (Borges 2005). Owing to steep altitudinal variations, the region possesses a temperate to sub-tropical climate (Ao & Bordoloi 2004). While some data on lichen and macrofungal diversity is available (Sati et al. 1997), not much is known on microfungal diversity of the northeastern region.

During a recent field trip to a few localities in the region, as part of an All-India Coordinated Project on Taxonomy of Fungi, samples of dead and decaying twigs and leaves were gathered. Of the several fungi isolated from these litter substrates, two new hyphomycetous taxa are described here.

Taxonomic description

***Vittalia* Gawas & Bhat anam. gen. nov.**

MYCOBANK MB510706

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunneae vel brunneae, pappim. Mycelium partim substrato immersum, partim superficiale. Stroma absentia. Setae et hyphopodia absentia. Conidiophora macronematica, mononematica, longa, angusta, mycelioida, curvata vel flexuosa, pallide brunnea vel brunnea, laevia vel

verrucosa, septata, ramosa vel non-ramosa. Cellulae conidiogenae monotreticae, nunquam cicatricem, integratae, terminales vel intercalare. Conidia sicca, solitaria, hyalina vel pallide brunnea, laevia vel verrucosa, cylindrica, rotundata ad duo extrimitas, recta vel allantoidea, euseptata.

Etymology: In honor of Prof. B.P.R. Vittal, University of Madras, India, a distinguished mycologist, who made enormous contributions to his discipline.

Conidial fungus, hyphomycete. Colonies effuse, pale to olivaceous brown, woolly. *Mycelium* partly immersed, partly superficial. *Stroma* none. *Setae* and *hyphopodia* absent. *Conidiophores* distinct, single, long, narrow, mycelioid, curved to flexuous, pale to olivaceous brown, smooth to verrucose, septate, branched or unbranched. *Conidiogenous cells* monotretic, non-cicatrized, integrated, terminal or intercalary. *Conidia* dry, solitary, hyaline to pale brown, smooth to verrucose, cylindrical, rounded at both ends, straight to allantoid, euseptate. Conidial secession rhexolytic.

Type species: *V. indica*

***Vittalia indica* Gawas & Bhat sp. nov.**

Fig. 1, 3-9

MYCOBANK MB510707

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunnea vel brunnea, papim. Mycelium partim substrato immersum, partim superficiale, ex hyphis septatis, ramosis, hyalinis vel pallide brunneis, 2-3.5 µm lat. Conidiophora macronematica, mononematica, longa, angusta, mycelioida, curvata vel flexuosa, pallide brunnea vel brunnea, laevia, septata, ramosa, ramus aucto longa, 2-3 µm lat. Cellulae conidiogenae monotreticae, nunquam cicatricem, integratae, terminales ad intercalare, cylindricae, 16-30 (-50) x 2-3 µm. Conidia sicca, solitaria, hyalina, verrucosa, cylindrica, rotundata ad duo extrimitas, allantoidea, 3-septata, 11-14 (-19) x 3-4.5 µm.

HOLOTYPE — On dead leaf of unidentified tree, Tezu, Arunachal Pradesh, India, coll. D.J. Bhat, 13.07.2006, Herb. No. HCIO 46950

Conidial fungus, hyphomycete. Colonies effuse, pale to olivaceous brown, wooly. *Mycelium* partly immersed, partly superficial, composed of septate, branched, hyaline to pale brown, 2-3.5 µm wide hyphae. *Conidiophores* distinct, single, long, narrow, mycelioid, curved to flexuous, pale to olivaceous brown, smooth, septate, branched, branches often very long, 2-3 µm wide. *Conidiogenous cells* monotretic, non-cicatrized, integrated, terminal or intercalary, cylindrical, 16-30 (-50) x 2-3 µm. *Conidia* dry, solitary, hyaline, verrucose, cylindrical, rounded at both ends, allantoid, 3-septate, 11-14 (-19) x 3-4.5 µm.

With darkly pigmented, smooth conidiophores, integrated, non-cicatrized, cylindrical, tretic conidiogenous cells and verrucose, euseptate conidia, *Vittalia* resembles three other hyphomycetous genera: *Bharatheeya* D'Souza & Bhat, *Diplococcium* Grove and *Spadicoides* S. Hughes (Ellis 1971, Eicker et al. 1985, D'Souza & Bhat 2002). These differ from each other in combinations of several distinct features as detailed in Table 1. The genus *Vittalia* is closer to



Fig. 1. *Vittalia indica*. Conidiophores, conidiogenous cells and conidia.

Bharatheeya in having long, slender, conidiophores and dry, solitary conidia. It is similar to *Diplococcium* in having terminal and intercalary conidiogenous cells and solitary, dry, euseptate conidia. It resembles *Spadicoides* in having branched conidiophores, terminal and intercalary conidiogenous cells and euseptate conidia. However, *Vittalia* is distinct from all these by monotretic

Table 1: Comparison of characters that distinguish *Vittalia* from other similar genera

Fungal genera	Conidiophores	Conidiogenous cells	Conidia	Reference
<i>Bharatheeya</i>	Erect, unbranched, septate, verrucose, inflated at the base	Polytretic	Solitary, distoseptate, smooth	D'souza and Bhat, 2002
<i>Diplococcium</i>	Erect, unbranched, septate, smooth	Polytretic	Catenate, smooth, euseptate	Ellis, 1971
<i>Spadicoides</i>	Erect, branched, septate, smooth	Polytretic	Solitary, smooth, euseptate	Ellis, 1971
<i>Vittalia</i>	Flexuous, septate branched, smooth	Monotretic	Solitary, verrucose, euseptate	Present observations

conidiogenous cells. A combination of characters such as branching of conidiophores and solitary, euseptate, verrucose nature of conidia supports the disposition of the fungus in the new genus, *Vittalia*, as *V. indica* sp. nov.

Helicoma indicum Gawas & Bhat sp. nov. Fig. 2, 10- 15

MYCOBANK MB510703

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunnea, velutinae. Mycelium substrato immersum. Conidiophora macronematica, mononematica, fasciculata vel synnemata, 4-13 (mean 9) coalesco, erecta, divergentibus, pallide brunnea ad apicem, darker ad basim, laevia, 2-6 (-15) septata, non-ramosa vel ramosa, up to 200 µm longa, 2-3 µm lat. Cellulae conidiogenae polyblasticae, denticulis, integratae, terminales, cylindricae, 14-40 x 1.5-2.5 µm. Conidia sicca, solitaria, laevia, hyalina, helicoidea, uniseptata, in 0.5-0.75 spiris convoluta, 5.5- 7.5 µm diam; filum 3-3.5 µm lat.

HOLOTYPE — On dead twig of unidentified tree, Mokochung, Nagaland, India, coll. D.J. Bhat, 09.07.2006, Herb. No. HCIO 46952.

Conidial fungus, hyphomycete. *Colonies* effuse, pale brown, velvety. *Mycelium* immersed. *Conidiophores* distinct, fasciculate to synnematos, 4-13 (mean 9) conidiophores held together, erect, divergent, pale brown towards apex, darker at base, smooth, 2-6 (-15) septate, unbranched to branched, up to 200 µm long, 2-3 µm wide. *Conidiogenous cells* polyblastic, sympodial, denticulate, integrated, terminal, cylindrical, 14-40 x 1.5-2.5 µm. *Conidia* dry, solitary, smooth, hyaline, uniseptate, coiled 0.5-0.75 times, 5.5- 7.5 µm diam; conidial filament 3-3.5 µm wide.

Moore (1955) provided a generic key to the helicosporous fungi. Our fungus is a saprobe with conidiophores aggregated to form fascicles or loose synnemata and simple, solitary, non-hygroscopic, two-dimensionally coiled, transversely

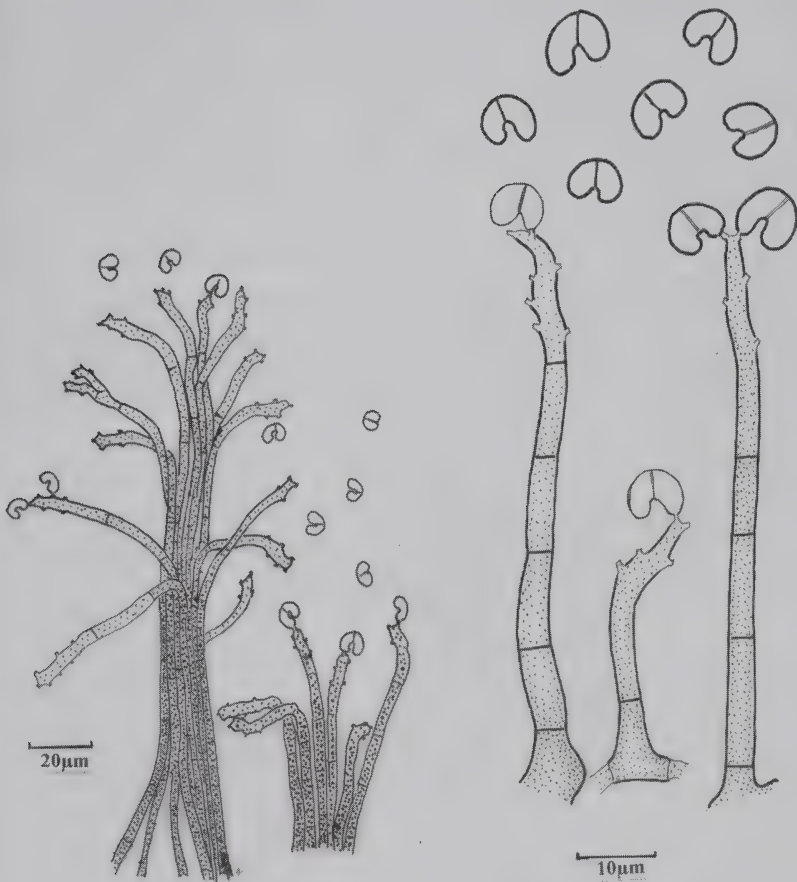


Fig. 2. *Helicoma indicum*. Conidiophores, conidiogenous cells and conidia.

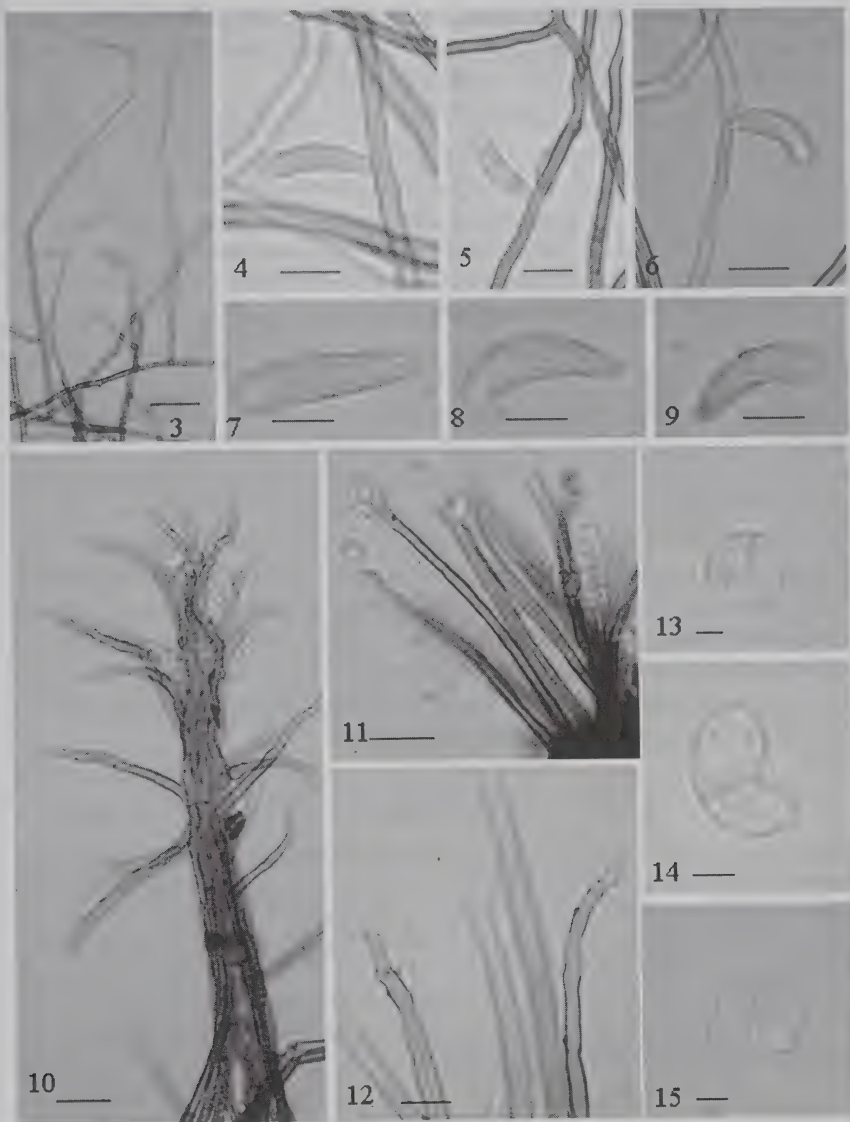
septate conidia. These characters support its placement in the genus *Helicoma* Corda, typified by *H. muelleri* Corda (Corda 1837), which presently accommodates about 50 species (Index Fungorum 2006). Pirozynski (1972) proposed to accommodate the species of *Helicoma* into two groups based on their mode of conidiogenesis. He included those with acrogenous conidia produced on sympodial, denticulate conidiogenous cells in the first group while species that produced hyaline, multiseptate, pleurogenous conidia on tooth-like conidiogenous cells borne on setiform conidiophores in the second (Pirozynski 1972). Following his scheme, we propose to place our fungus in the second group.

Goos (1986) reviewed 32 of the then known 40 species, segregated them into four Sections, viz. *Helicoma*, *Atroseptatum*, *Violaceum* and *Monilipes* and provided a useful key to each of the sections in the genus. With conidia borne acropleurogenously on conspicuous denticles, *H. indicum* fits well in the Sect. *Helicoma*. On comparison, the fungus was found to be quite different from any of the earlier known species, the distinct features being its uniseptate conidia and overall dimensions (Table 2).

Table 2: Comparison of species of *Helicoma* belonging to Section *Helicoma*

Species	Conidiophore length (µm)	Conidial diameter (µm)	Number of septa per conidium	Number of coils per conidium
<i>H. ambiens</i> Morgan	up to 600	18-20	6-8	1.5-1.75
<i>H. asperothecum</i> Linder	55-250	15-25	8-10	1.5-1.75
<i>H. conicodentatum</i> Linder	20-125	14-20	5-7	1.25-1.75
<i>H. dennisii</i> Ellis	up to 470	19-22	7-8	1.25-1.5
<i>H. indicum</i> Gawas & Bhat	up to 200	5.5-7.5	1	0.5-0.75
<i>H. inflatum</i> Linder	18-120	13-18	5-6	1.25-1.75
<i>H. muelleri</i> Corda	up to 200	14-21	5-8	1.5-1.75
<i>H. narsapurens</i> Rao & Rao	145-335	20-27	3-8	1.25-1.5
<i>H. recurvum</i> (Petch) Linder	125-300	15-20	6-8	1-1.75
<i>H. taenia</i> Moore	up to 600	15-20	7-16	1.5-1.75
<i>H. taiwanensis</i> Matsushima	100-400	7-15	3-5	1-1.5

Helicoma indicum resembles the genera *Trochophora* R.T. Moore and *Helicomycetes* Link in having two dimensionally coiled, simple, solitary transversely septate conidia. *H. indicum* however differs from the former in having fasciculate to loosely aggregated synnemata, hyaline conidia and unthickened conidial septa.



Figs. 3-9. *Vittalia indica*. 3. Mycelioid conidiophores (bars= 20µm) 4-6. Monotretic conidiogenous cells (bars= 10µm). 7-9. Allantoid 3-septate conidia (bars= 5 µm). 10-15. *Helicoma indicum*. 10,11. Conidiophores in fascicles with attached conidia (bars= 20 µm), 12. Polyblastic denticulate conidiogenous cells (bar= 10 µm). 13-15. Helicoid uniseptate conidia (bar= 5 µm).

Helicoma indicum differs from the other morphologically similar genus *Helicomyces* in its non-hygroscopic nature of conidia and in being thicker in proportion to the length of the conidial filament.

Using rDNA sequence analysis of helicosporous fungi, Tsui & Barbee (2006) and Tsui et al. (2006) inferred that this group of anamorphic fungi is polyphyletic and that the lack of monophyly is due to the inefficiency of the traditionally used morphological characters to delimit the genera. They said that, though no single morphological character perfectly correlates with the clades of the phylogenetic tree obtained during the study, a combination of characters such as conidiophore color, conidial color and conidial ontogeny are phylogenetically informative. They further suggested that characters such as prominence of conidiophores, thickness of conidial filaments and hygroscopic nature of conidia are more useful for species delimitation than for predicting higher level relationships. This has challenged the existing taxonomic and nomenclatural status of helicosporous fungi. In any case, until a thorough revision of the group is made, the existing genera are considered valid. In the present setup, we would like to accommodate our fungus as a new species in the genus *Helicoma* following the morphological characters as mentioned in the generic description. To quote Seifert & Gams (2001): 'Identification of most of the fungi is made using morphological characters, although the age of molecular biology provides us with molecular diagnostics. Using morphological characters, anamorph genera can be delimited that are practical for identification purposes, and are often (but not always) phylogenetically natural'.

Acknowledgments

DJB is thankful to the Ministry of Environment & Forests, Government of India, for a research grant support and the University Grants Commission, New Delhi, for a DRS level Special Assistance Programme to the Department of Botany, Goa University. Sri K.O. Isaac, ABL Biotechnologies, Chennai, India, is thanked for logistic support during the field trip to N-E India. PG is thankful to the MOENF, New Delhi, for a research scholarship. We are indebted to Drs. B. Kendrick (University of Victoria, B.C., Canada) and R. Goos (University of Rhode Island, Kingston, RI, USA), for kindly reviewing the manuscript and giving valuable suggestions.

Literature cited

- Ao M, Bordoloi S. 2004. The Amphibian Fauna of Nagaland, India: Species and Habitats. *Froglog* 62: 3.
- Borges RM. 2005. The Frontiers of India's Biological Diversity. *Tropinet* 16(3): 1-3.
- Corda ACL. 1837. *Icones Fungorum hucusque cognitorum*. Vol 1.
- D'Souza M, Bhat DJ. 2002. *Bharatheeya*, a new hyphomycete genus from India. *Mycotaxon* 83: 397-403.

- Eicker E, Sinclair R, Bhat DJ. 1985. Branching in *Spadicoides*. Trans. Br. Mycol. Soc. 85: 736-738.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, England. 608p.
- Goos RD. 1986. A review of the anamorph genus *Helicoma*. Mycologia 78(5): 744-761.
- Index Fungorum. 2006. www.indexfungorum.org
- Linder DH. 1929. A Monograph of the Helicosporous Fungi Imperfecti. Annals Missouri Bot. Gard. 16(3): 227-348, 350-388.
- Moore RT. 1955. Index to the *Helicosporae*. Mycologia 47(1): 90-103.
- Pirozynski KA. 1972. Microfungi of Tanzania Part 1: Miscellaneous fungi on oil palm. Mycol. Pap. 129: 1-39.
- Sati SC, Saxena J, Dubey RC. 1997. Himalayan Microbial Diversity. 2nd Vol. Today & Tomorrow Publishers, New Delhi. 517p.
- Seifert KA, Gams W. 2001. The taxonomy of anamorphic fungi. In: The Mycota VII Part A. Systematics and Evolution (Eds. McLaughlin, McLaughlin, Lemke) Springer-Verlag Berlin Heidelberg, pp 307-347.

Anomoloma, a new genus separated from Anomoporia on the basis of decay type and nuclear rDNA sequence data

TUOMO NIEMELÄ¹, KARL-HENRIK LARSSON²,
YU-CHENG DAI³ & ELLEN LARSSON²

¹ Finnish Museum of Natural History, Botanical Museum
P.O.Box 7, FI-00014 University of Helsinki, Finland

² Göteborg University, Department of Plant and Environmental Sciences
P.O. Box 461, SE-40530 Göteborg, Sweden

³ Institute of Applied Ecology, Chinese Academy of Sciences
Wenhua Road 72, Shenyang 110016, China

Abstract—Five species of *Anomoporia*, and related but deviating material from South China, were studied microscopically and sequenced. Bayesian and maximum parsimony analyses were conducted using nuclear ribosomal ITS and large-subunit DNA regions. The species belong to a subclade within or close to the euagarics clade. The brown-rot-causing species *A. bombycina* (type of the genus *Anomoporia*), *A. vesiculosa*, and *A. kamtschatica* belong to a genus complex together with *Ceraceomyces*, *Hypochniciellum*, *Irpicondon* and *Plicaturopsis*, but their inner hierarchy needs further study before conclusions on genus limits can be made. Four strongly rhizomorphic species of *Anomoporia* are associated with white-rot, and they were found to form a well-supported clade. Consequently, a new genus *Anomoloma* is described. The following new combinations are made: *Anomoloma albolutescens* (type of the genus), *A. myceliosum*, *A. flavissimum*, and a new species is described from the South Chinese material: *A. rhizosum*. Numerous new records of *A. flavissimum* expand considerably its known range in China.

Key words—*Basidiomycota*, phylogeny, polypore, taxonomy

Introduction

The genus *Anomoporia* Pouzar was established for a small group of resupinate polypore species with monomitic hyphal structure and amyloid spores (Pouzar 1966). The type of the genus, *A. bombycina* (Fr.) Pouzar, causes intensive brown-rot on coniferous trees. Similarly brown-rot-causing are the closely related *A. vesiculosa* Y.C. Dai & Niemelä, described from China and later also found in Japan (Dai & Niemelä 1994, Dai 1996), and *A. kamtschatica* (Parmasto) Bondartseva, which is more widespread throughout northern Asia and Europe.

Pouzar (1966) also included some other species of resupinate polypores in *Anomoporia*, viz. *A. albolutescens* (Romell) Pouzar and *A. myceliosa* (Peck) Pouzar. Later Niemelä (1994) described *A. flavissima* from material collected by Erast Parmasto and others from the Russian Far East.

When studying the genus, Niemelä (1994) pointed out that while *A. bombycina* and *A. kamtschatica* have basidiocarps with cottony margins and cause brown-rot, *A. albolutescens*, *A. myceliosa* and *A. flavissima* are strongly rhizomorphic and grow on white-rotted wood. The type of rot is usually regarded as an important character for the classification of wood decay fungi, and recent molecular phylogenetic investigations seem to support that conclusion (e.g. Hibbett & Donoghue 2001, Hibbett & Thorn 2001). In order to test whether the different decay characteristics present in *Anomoporia* suggest that the genus is composed of phylogenetically disparate elements, a sequence dataset was compiled and analysed. Larsson et al. (2004) who studied the evolution of homobasidiomycetes with an emphasis on species with effused basidiomata included two species of *Anomoporia* in their analyses: the type species, and *A. kamtschatica*. These taxa formed, together with *Amylocorticium cebennense* (Bourdot) Pouzar, *A. subincarnatum* (Peck) Pouzar, *Ceraceomyces tessulatus* (Cooke) Jülich, and *Hypochniciellum subillaqueatum* (Litsch.) Hjortstam, a subclade within or close to the euagarics clade. There are no other *Anomoporia* sequences available in GenBank.

When designing the present dataset we expanded on the results by Larsson et al. (2004) and on the observation that *Anomoporia*, *Amylocorticium*, and *Hypochniciellum* all have amyloid spores. We also took into consideration suggestions from the literature that *Anomoporia myceliosa* might be related to *Porpomyces* (Bondartseva 1998) or *Ceriporiopsis* (Ryvarden & Gilbertson 1993) and added the type species from these two genera to our dataset. Larsson (2001) showed that *Porpomyces* is related to *Trechispora*, and that these genera belong to a well delimited lineage, the trechisporoid clade (Larsson et al. 2004, Binder et al. 2005). *Ceriporiopsis gilvescens* (Bres.) Domański has to our knowledge not been included in any molecular phylogenetic analyses before.

New Chinese finds of *Anomoporia flavissima* expand its known range considerably, and a related but undescribed species was collected twice in South China. These observations are also reported here.

Materials and methods

Data on the material used for phylogenetic analyses are listed in Table 1 together with GenBank accession numbers.

Ten sequences from the nuclear ribosomal ITS and large-subunit DNA regions were generated for this study. Ten additional sequences were downloaded from GenBank. *Meruliopsis taxicola* (Pers.) Bondartsev, *Basidioradulum radula* (Fr.)

Nobles and *Sistotrema brinkmannii* (Bres.) J. Erikss. representing the phlebioid, hymenochaetoid, and cantharelloid clades (Larsson et al. 2004), respectively, are included to aid in the polarisation of molecular characters. In analyses *Sistotrema brinkmannii* is used as outgroup in order to root the tree.

DNA was isolated from herbarium material using DNeasy plant mini kit (QIAGEN, Valencia), following manufacturer's recommendations. PCR reactions were carried out using Ready-To-Go™ PCR beads (Amersham Pharmacia Biotech). Primers used to amplify the complete ITS region were ITS1F and ITS4B (Gardes & Bruns 1993) and for the partial LSU region LR0R and Lr7 (Vilgalys & Hester 1990).

Amplified products were purified using Qiaquick spin columns (QIAGEN). Primers used for sequencing were ITS1, ITS3, ITS4 (White et al. 1990), Ctb6 (<http://mendel.berkeley.edu/boletus.html>), Lr5, and LR3R (Vilgalys & Hester 1990). 50–75 ng of PCR product were used in each sequencing reaction using DTCS Quick Start Kit (Beckman Coulter, Fullerton). Sequences were obtained using CEQ 8000 DNA analysis system (Beckman Coulter). Sequences

Table 1. Specimens used for phylogenetic analyses. Herbarium acronyms follow Holmgren et al. (1990).

Taxon	Voucher	Herbarium	GenBank number
<i>Amyloathelia crassiuscula</i>	K 169/796	GB	DQ144610
<i>Amylocorticium cebennense</i>	JS 24813	O	AY463376/AY586627
<i>Amylocorticium subincarnatum</i>	Å. Strid	GB	AY463377/AY586628
<i>Amylocorticium subsulphureum</i>	M. Ryberg	GB	DQ144611
<i>Anomoloma albulutescens</i>	RP 3549	H	DQ144612
<i>Anomoloma flavissimum</i>	TN 6397	H	DQ144613
<i>Anomoloma myceliosum</i>	TN 5911	H	DQ144614
<i>Anomoloma rhizosum</i>	YCD 4031	H	DQ144616
<i>Anomoporia bombycina</i>	GG 612-92	O	AY463378/AY586629
<i>Anomoporia kamtschatica</i>	KHL 11072	GB	AY463379/AY586630
<i>Anomoporia kamtschatica</i>	K 426	GB	DQ144615
<i>Anomoporia vesiculosa</i>	MN 934	O	DQ144617
<i>Basidioradulum radula</i>	NH 9453	GB	AF347105
<i>Ceraceomyces tessulatus</i>	KHL 8474	GB	AY463391/AY586642
<i>Ceriporiopsis gilvescens</i>	Hausknecht	O	DQ144618
<i>Hypochnicium subillaqueatum</i>	KHL 8493	GB	AY463431/AY586679
<i>Irpicondon pendulus</i>	B. Nordén	GB	DQ144619
<i>Meruliopsis taxicola</i>	KHL 8541	GB	AY463408/AY586656
<i>Plicaturopsis crispa</i>	KHL 8615	GB	DQ144620
<i>Porpomyces mucidus</i>	KHL 11062	GB	AF347091
<i>Sistotrema brinkmannii</i>	NH 11412	GB	AF506473

were edited and assembled using Sequencer 3.1 (Gene Codes, Ann Arbor). Sequences were aligned using the data editor in PAUP* (Swofford 2003). Gaps for insertion-deletion events were manually introduced in the alignment.

The total aligned dataset included most of the 5.8 gene, ITS2, and the 5' end of 28S (LSU) and consisted of 1837 positions including gaps. Complete sequences were obtained for all the specimens except for *Anomoporia flavissima*, which has a short LSU sequence, and *Anomoporia kamtschatica* K426, which lacks the ITS region. The ITS2 region was deemed too variable to allow unambiguous alignment and was excluded from the final analyses. The analyzed dataset had 1412 characters of which 191 were variable but parsimony uninformative and 189 were parsimony informative.

Heuristic searches for the most parsimonious trees were performed using PAUP*. All the transformations were considered unordered and equally weighted. Gaps were treated as missing data. Bootstrapping was performed using 1000 heuristic search replicates with 10 random taxon addition sequence and TBR swapping.

For a Bayesian inference of phylogeny, MrModeltest 2.2 (Nylander 2004) was used to estimate separate best-fit models of evolution for 5.8S and nLSU. A heterogeneous Bayesian inference run was set up in MrBayes 3.0B4 (Ronquist & Huelsenbeck 2003) with model parameters estimated separately for 5.8S and nLSU. Eight Metropolis-Coupled Markov Chain Monte Carlo (MCMCMC) chains with default temperatures were initiated; these were run for 5 million generations with tree and parameter sampling every 4 000 generations (1 250 trees). The burn-in was set to 20% (250 trees).

Microscopic study was done, spores were measured, and illustrations were drawn from sections mounted in Cotton Blue (abbreviated CB): 0.1 mg aniline blue (Merck 1275) dissolved in 60 g pure lactic acid; CB+ means cyanophily, CB(+) weak but distinct cyanophilous reaction, CB- acyanophily. Amyloid and dextrinoid reactions were tested in Melzer's reagent (IKI): 0.5 g crystalline iodine (I), 1.5 g potassium iodide (KI), 22 g chloral hydrate, aq. dest. 20 ml; IKI- means neither amyloid nor dextrinoid reaction. Occasionally also 5% KOH was used as mountant.

30 spores were measured from each specimen for spore dimensions using $\times 1250$ magnification, phase contrast, and oil immersion. Microscope eyepiece scale bar with 1- μ m-grid was used for measuring, and dimensions were estimated subjectively with an accuracy of 0.1 μ m. This procedure was discussed more thoroughly in Miettinen et al. (2006). In presenting the variation of spore size, 5% of the measurements out of each end of the range are given in parentheses (if applicable). L = mean length (arithmetical mean of all the spores), W = mean width, Q = extreme values of length/width ratios among the studied specimens, n = number of spores measured from given number of specimens.

Results of phylogenetic analyses

Maximum parsimony (MP) analysis gave 18 MP trees in three islands with a consistency index of 0.6583 including uninformative changes. Fig. 1 shows one of the MP trees as a phylogram.

The ingroup, which includes all the selected representatives of *Anomoporia*, *Amyloathelia*, *Amylocorticium*, *Hypochniciellum*, *Ceraceomyces*, *Irpicondon*, and *Plicaturopsis*, form a moderately supported clade (86% bootstrap). Within the ingroup, basal nodes collapse to a polytomy with eight branches representing the white-rot *Anomoporia* species (100% bootstrap), *Amylocorticium* (86%), *Anomoporia bombycina/vesiculosa* (100%), *Anomoporia kamtschatica*, *Ceraceomyces tessulatus*, *Amyloathelia crassiuscula* Hjortstam & Ryvarden, *Hypochniciellum subillaqueatum*, and *Irpicondon/Plicaturopsis* (100%).

For the 5.8S and nLSU loci, MrModeltest suggested the SYM and GTR+I+G models respectively. Plotting the cold-chain likelihood values against the generation number revealed that stationarity was reached at approximately generation 10 000, well in advance of the burn-in threshold. Chain mixing was found to be satisfactory, with ≥ 971 cold-chain switches during the search.

In the Bayesian tree (Fig. 2) the position for *Amyloathelia crassiuscula*, *Ceraceomyces tessulatus*, and *Hypochniciellum subillaqueatum* is different compared to the MP tree. This is not unexpected and is in accordance with the lack of bootstrap support for the nodes leading to these taxa. In general, support for the topology appears better in the Bayesian tree with posterior probability values of 1.0 at nine nodes compared to four nodes with 100% bootstrap support in the MP tree. The most notable differences are the high support for the ingroup and for *Amylocorticium* as a monophyletic genus. The *Anomoporia* clade receives a posterior probability value of 0.85 that is clearly below what should be regarded as a reliable value for node support in Bayesian analyses (Ronquist 2004, Zander 2004). Thus, the result of the Bayesian analysis is more or less in congruence with the MP analysis for the residual *Anomoporia* clade.

Discussion

In the molecular phylogenetic analyses (Figs. 1, 2) four specimens of *Anomoporia* associated with a white-rot decay of the substrate were found to form a well-supported clade that we name the *Anomoloma* clade. The rest of the tested *Anomoporia* species become separated in two groups, one with *A. bombycina* and *A. vesiculosa*, and the other with *A. kamtschatica*. The topology for *Anomoporia* can be interpreted in three ways. The first possibility is to divide *Anomoporia* in three genera with *Anomoporia* restricted to *A. bombycina* and *A. vesiculosa*, and two new genera for the *Anomoloma* clade and for *A. kamtschatica*. This solution has full statistical support from the phylogenetic analyses. The second

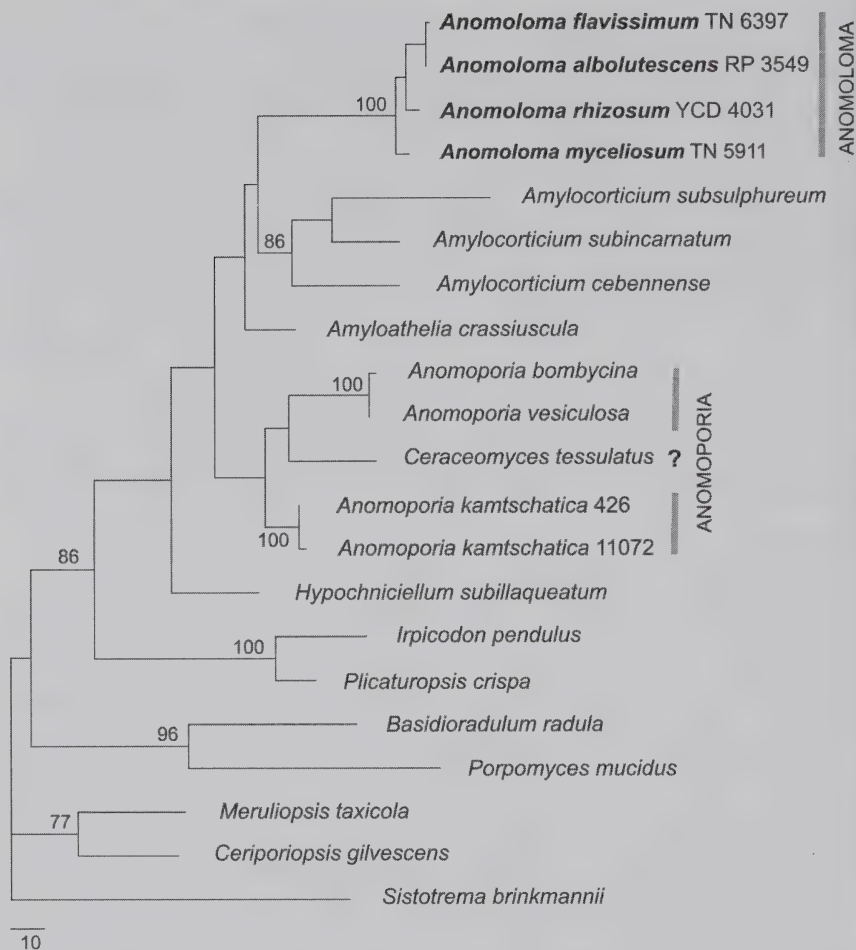


Fig. 1. Phylogenetic relationships of *Anomoporia* and related genera inferred from maximum parsimony analysis. One of 18 most parsimonious trees showing branch lengths proportional to the number of changes along the branch. Numbers indicate bootstrap proportions $\geq 50\%$.

possibility is to restrict *Anomoporia* to brown-rotting taxa (*A. bombycina*, *A. vesiculosa*, and *A. kamtschatica*) and create a new genus for the white-rot group. There is no support for such a circumscription of *Anomoporia* and it does not take into account the close relation to *Ceraceomyces tessulatus* implied by the phylogram. The third solution would be to keep *Anomoporia* together and accept the ingroup as one large genus, a solution that has statistical support but breaks radically with the present classification. *Anomoporia* would then include also *Amylocorticium*, *Irpicondon*, and *Plicaturopsis* and portions of *Ceraceomyces* and *Hypochniciellum*.

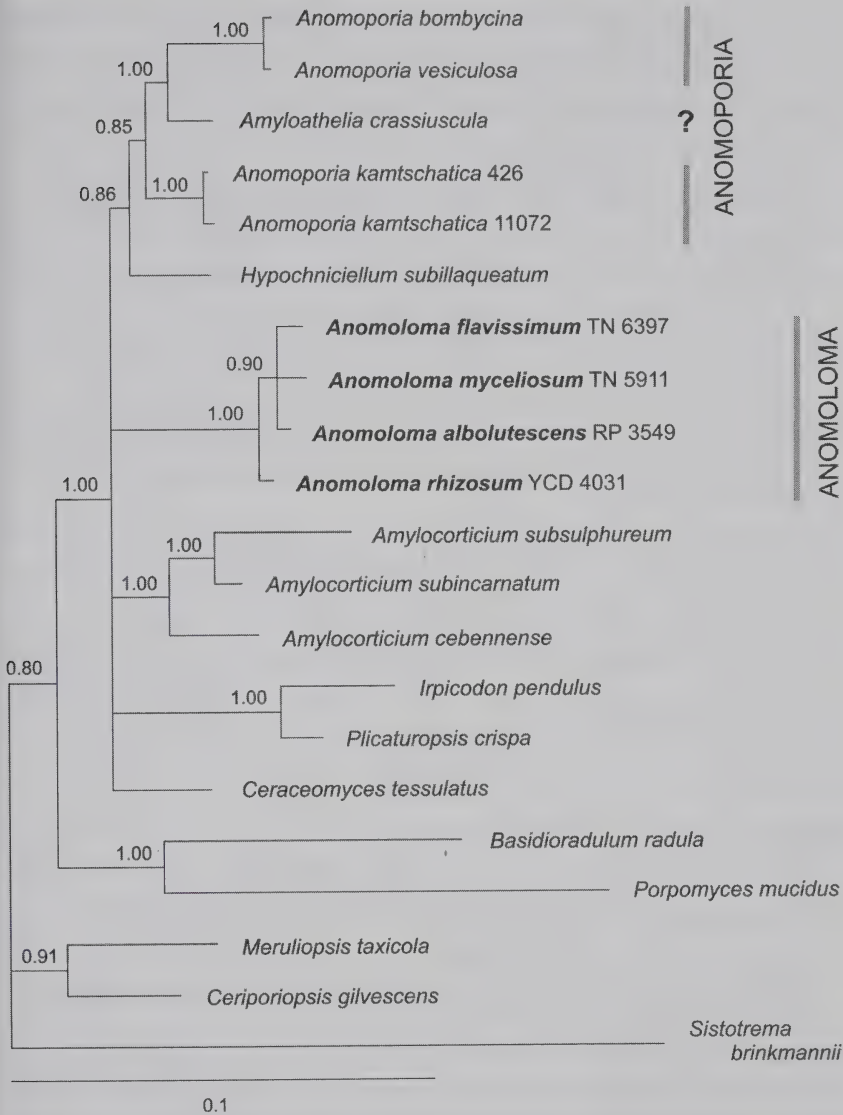


Fig. 2. Phylogenetic relationships of *Anomoporia* and related genera inferred from Bayesian analysis of combined nuclear 5.8S and ribosomal LSU gene regions (50% majority rule consensus tree) showing branch lengths. Numbers represent posterior probability values ≥ 0.80 .

To broaden the concept of *Anomoporia* to cover the whole ingroup is unacceptable because the genus thus created can not be morphologically defined and would make a number of name changes necessary. Also, too many species are still not sequenced, and therefore drastic changes in classifications based on

incomplete taxon sampling should be avoided. Instead, we prefer to regard the ingroup as representing a suprageneric taxon. We conclude that *Anomoporia* must be split but the data presented here only supports segregation of the white rot taxa. We propose to keep the rest of *Anomoporia* as it is, until further species are studied and the general picture becomes clearer.

For the white-rot associated species now placed in *Anomoporia* we propose the new genus *Anomoloma*. At present it contains four closely related species. The genus does not seem to have a closer connection with any of the species of corticioid fungi included in the analysis, or otherwise known to us.

Anomoporia myceliosa is morphologically fairly similar to *Porpomyces mucidus* (Pers.) Jülich, although the latter lacks the amyloid reaction in the spore wall. Some authors have merged *P. mucidus* and *A. myceliosa* in the same genus, e.g. Bondartseva (1998) in *Fibuloporia*. This link, however, is not supported in our study or in earlier published molecular analyses: *Porpomyces mucidus* is in fact related to *Trechispora*, and belongs to a quite different clade (Larsson 2001, Larsson et al. 2004).

Ryvarden and Gilbertson (1993) noted that *Anomoporia myceliosa* has decay characteristics that differ from the type of *Anomoporia*, and they placed *A. myceliosa* in *Ceriporiopsis*. This genus is typified by *C. gilvescens*. In our analyses *C. gilvescens* falls outside the ingroup and is most close to *Meruliopsis taxicola*. The result implies that *C. gilvescens* belongs in the phlebioid clade sensu Larsson et al. (2004), which effectively rules out any relationship with *Anomoporia myceliosa*.

Taxonomy

Anomoloma Niemelä & K.H. Larss., gen. nov.

MYCOBANK MB 504173

Generis Anomoporiae similis, sed cariete alba protrudens et cum basidiomatibus margine rhizomorphosis.

Type species: *Polyporus albolutescens* Romell.

Etymology: *anomos* (Gr.) lawless, i.e. irregular, deviating from the common habit, referring to the rhizomorphic outline; *loma* (Gr., neuter) margin, edge.

Species in the genus *Anomoloma* are characterized by resupinate, strongly rhizomorphic basidiocarps and white, cream or yellow colours. Hyphal structure is monomitic, hyphae slightly cyanophilous and with clamp connections; spores are ellipsoid with slightly thickened wall, amyloid, approximately 3–5×2–4 µm, Q=1.2–1.4. The species cause white-rot mostly on woody debris of angiosperm and gymnosperm trees.

The following species are included in the new genus:

Anomoloma albolutescens (Romell) Niemelä & K.H. Larss., comb. nov.

MYCOBANK MB 504174

Basionym: *Polyporus albolutescens* Romell, Arkiv Botanik 11:11, 1911.

Lectotype: Sweden, Lapland, comm. Romell (Bresadola Herbarium, BPI 237956, studied), selected by Lowe (1966).

***Anomoloma myceliosum* (Peck) Niemelä & K.H. Larss., comb. nov.**

MYCOBANK MB 504175

Basionym: *Poria myceliosa* Peck, N.Y. State Mus. Bull. 54:952, 1902.

Lectotype: U.S.A., New York, Franklin, Floodwood, *Tsuga*, 31.VIII.1900 C.H. Peck 53 (NYS, studied), selected by Niemelä (1994).

***Anomoloma flavissimum* (Niemelä) Niemelä, K.H. Larss. & Y.C. Dai, comb. nov.**

MYCOBANK MB 504176

Basionym: *Anomoporia flavissima* Niemelä, Ann. Bot. Fennici 31:102, 1994.

Holotype: Russia, Khabarovsk, Selikhino, Kabansopka, *Tilia amurensis*, 17.VIII.1961 Raitviir (TAA 42267; isotype in H, both studied).

***Anomoloma rhizosum* Y.C. Dai & Niemelä, spec. nov.**

FIGURE 3

MYCOBANK MB 504177

Species Anomolomatis flavissimi similis, sed colore cremeo-lutescens et sporis magnioribus, 4.1–5.3×3–4 µm.

Holotype: China, Sichuan Prov., Aba Auto. State, Jiuzhaigou, on rotten *Tsuga chinensis*, 14.X.2002 Y.C. Dai 4160 (H; isotype in HMAS).

Notes on the species

Anomoloma rhizosum

Basidiocarp resupinate, ca. 5×10 cm wide, 1–2 mm thick, felty or very soft corky. Sterile margin irregular, 1–4 mm wide, swollen or thinning out, pale yellow or ochraceous; thread-like, straw-coloured rhizomorphs arising from margin and penetrating in decayed wood. Pore area yellowish: buff, pinkish buff, buff-yellow or luteous, oldest centre with a brownish tint; pores angular, regular, (3–)4–5 per mm. Section: subiculum felty, up to 1 mm thick, the ochraceous-yellow colour being strongest at basal layer next to substrate, tubes in section straw-coloured or buff-yellow.

Hyphal system monomitic (Fig. 3), hyphae with clamp connections. Subiculum with interwoven hyphae, (2.6–)3.3–4.2 µm in diam., walls mostly thick (frequently up to 1 µm), CB+, IKI–, KOH–, yellow especially close to the attachment, rarely covered with minute hyaline crystals. Tube trama with interwoven but longitudinally oriented hyphae, (2.4–)2.9–3.3(–3.8) µm in diam., walls fairly thin, CB(+), yellow in IKI, KOH–. Hymenium with rather loosely arranged palisade of clavate basidioles and 4-sterigmate, clavate basidia 14–18.5×5–5.8 µm; no cystidia; at tube bottoms hymenium mostly replaced by tufts of erect hyphidia. Hyphal tips at dissepiment edge smooth, regular, frequently containing bead-like oil globules. Basidiospores ellipsoid and often with truncated ends, slightly thick-walled, amyloid, CB(+), (3.9–)4.1–5.3

$(-5.5) \times (2.9-3-4(-4.1)) \mu\text{m}$, $L=4.82 \mu\text{m}$, $W=3.57 \mu\text{m}$, $Q=1.34-1.37$ ($n=60/2$); often guttulate.

The species greatly resembles *A. flavissimum*, but spores are distinctly larger—in *A. flavissimum* they are $(2.9-3.2-4.1(-4.4)) \times (2.1-2.4-3.1(-3.3)) \mu\text{m}$, $L=3.66 \mu\text{m}$, $W=2.79 \mu\text{m}$, $Q=1.26-1.36$ (Niemelä 1993). In the hymenium of *A. flavissimum* there are thin-walled vesicular cystidia, but such were not seen in the new species. The layered structure of the subiculum in *A. flavissimum* contrasts to the fairly uniform hyphal arrangement in *A. rhizosum*. Host characteristics may be unimportant among these fungi at the final successional stage of wood decomposition.

SPECIMENS EXAMINED—China. Sichuan: Aba Auto. State (see type). Jiuzhai Co., Jiuzhaigou Nat. Res., on rotten *Tsuga chinensis* in mixed forest, alt. 2800 m, 12.X.2002 Dai 4031 (H, HMAS).

Anomoloma flavissimum

The description of the species (Niemelä 1994) was based on ample herbarium materials collected from the Russian Far East by Erast Parmasto (Tartu, Estonia) and others. These collections exhibited a bright yellow colour and large basidiocarps with strongly developed rhizomorphs at their margins. Later the species was found in China (Dai 1996), and in 1998 Y.C.D. and T.N. could study it in the virgin forest of Changbai in Northeast China close to the type locality in the Russian Far East. Later on Y.C.D. together with his doctoral students have collected the species in several other Chinese localities (see Specimens Examined below), and *A. flavissimum* is now a fairly well-known species.

Fresh basidiocarps and rhizomorphs of *A. flavissimum* are bright sulphur yellow. The fungus grows in old natural forests with temperate vegetation at the altitude around 800–1200 metres in Changbai, but up to 3000 m in Tibet. The most common tree genera in the forests are *Abies*, *Pinus*, *Acer*, *Populus*, and *Quercus*. Characteristic of the species is that fructifications seem to arise from the ground, patchwise over areas of tens of square metres. In such areas yellow rhizomorphs are seen among soil debris, and small and large basidiocarps emerge on old stumps and rotten fallen trunks of any tree species. Often the basidiocarps cover areas of 20–50 cm or more along the lower side of tree trunks. This way of growing strongly implies that the species is mycorrhizal. However, wood under the basidiocarps was intensively white-rotted.

Y.C.D. from our team has collected and observed polypores in Chinese forest areas for over ten years. It seems that *Anomoloma flavissimum* is a very rare species, found in old-growth forests only. Evidently it is sensitive to changes in forest ecology, and threatened throughout its range.

SPECIMENS EXAMINED—China. Jilin: Antu Co., Changbaishan Nat. Res., *Populus davidiana*, 15.IX.1998 Niemelä 6362 (H); *Betula*, 17.IX.1998 Niemelä 6397 (H); *Populus*,

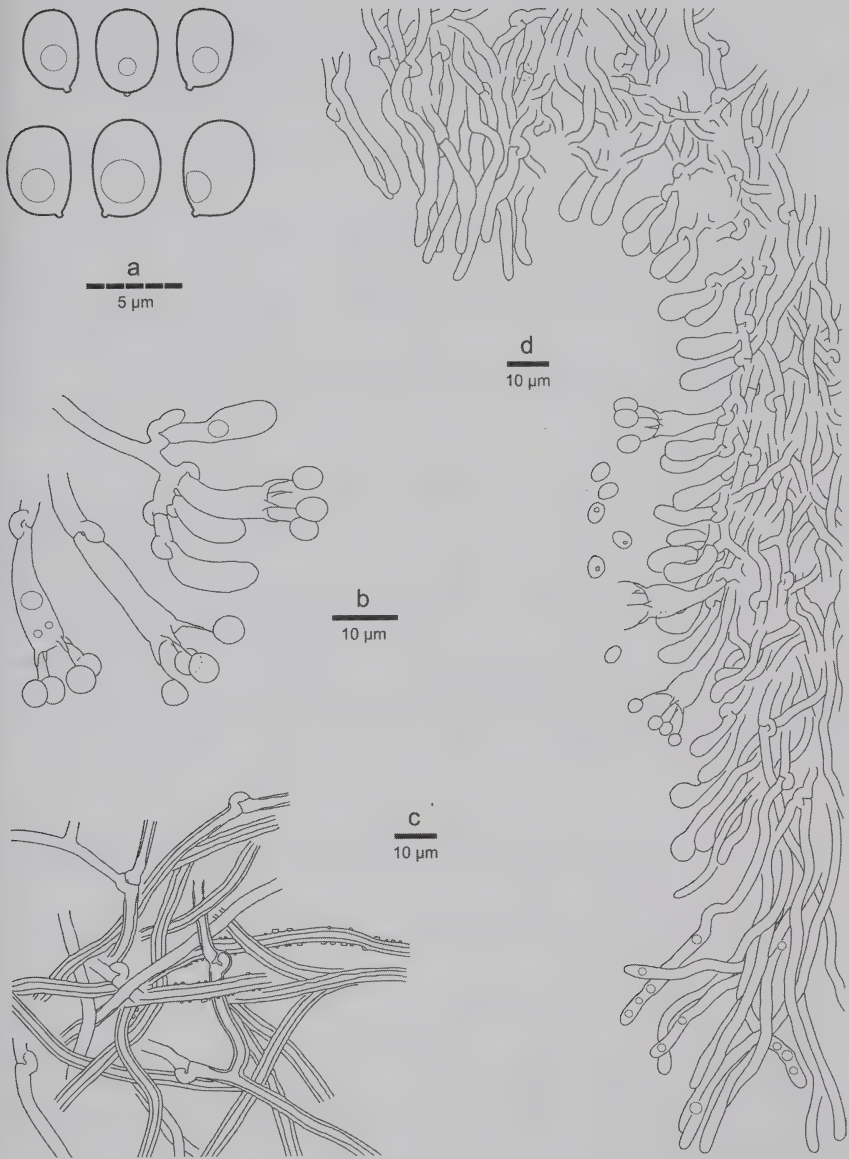


Fig. 3. Microscopy of *Anomoloma rhizosum*, drawn from holotype, mounted in Cotton Blue. a) Spores, b) basidia and basidioles, c) hyphae from subiculum, d) vertical section through tube dissepiment, showing a tuft of hyphidia at tube bottom, hymenium, tube trama, and hyphal tips at tube orifice.

21.IX.2002 Dai 3903. Heilongjiang: Yichun, Fenglin Nat. Res., on gymnosperm wood, 9.IX.2002 Dai 3741. Ning'an Co., "Underground Forest Park", *Abies*, 14.IX.2004 Yuan 595; *Pinus*, 15.IX.2004 Yuan 665, 732. Xizang Auto. Reg.: Linzhi Co., Bayi, *Pinus densata*, 2.VIII.2004 Dai 5568; *Quercus aquifolioides*, 1.VIII.2004 Dai 5533. Zhejiang Prov.: Lin'an Co., Tianmushan Nat. Res., on angiosperm wood, 17.X.2004 Dai 6474; *Pinus*, 17.X.2004 Dai 6475.

—All preserved in HMAS, unless otherwise indicated. Collections listed by Niemelä (1994) are not repeated here.

Anomoloma albolutescens and *A. myceliosum*

These species were described and illustrated in Niemelä (1994). In North Europe they grow in rich, spruce-dominated mixed forests abundant with coarse woody debris and preferably old-growth or near-virgin. Both are rare and considered to be threatened (Rassi et al. 2001).

Acknowledgements

The author T.N. thanks the Ministry of Environment (Finland) for research grants (PUTTE Research Programme for Deficiently Known and Threatened Forest Species). K.H.L. and E.L. thank The Swedish Species Information Centre (ArtDatabanken) for research funding. Y.C.D. thanks the Ministry of Science and Technology, P.R. China, for a grant (project 2005DFA30280). Prof. Teuvo Ahti (Helsinki) kindly helped in finding a name for the new genus, and in polishing the Latin descriptions. Mr Otto Miettinen, Lic.Phil., checked the manuscript and gave constructive comments. We also thank the two reviewers, Dr. Joost A. Stalpers (Utrecht) and Prof. Urmas Kõljalg (Tartu), for corrections and improvements.

References

- Binder M, Hibbett DS, Larsson KH, Larsson E, Langer E, Langer G. 2005. The phylogenetic distribution of resupinate forms across the major clades of mushroom-forming fungi (*Homobasidiomycetes*). *Syst. Biodivers.* 3: 113–157.
- Bondartseva MA. 1998. Definitorium fungorum Rossicae, ordo *Aphylllophorales* 2. Nauka: Sankt-Peterburg.
- Dai YC. 1996. Changbai wood-rotting fungi 7, a checklist of the polypores. *Fungal Science* 11: 79–105.
- Dai YC, Niemelä T. 1994. Changbai wood-rotting fungi 1, a new species of *Anomoporia* (*Basidiomycetes*). *Ann. Bot. Fennici* 31: 65–69.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes, application to the identification of mycorrhizas and rusts. *Molec. Ecol.* 2: 113–118.
- Hibbett DS, Donoghue MJ. 2001. Analysis of character correlations among wood decay mechanisms, mating systems, and substrate ranges in *Homobasidiomycetes*. *Syst. Biol.* 50: 215–242.
- Hibbett DS, Thorn RG. 2001. *Basidiomycota: Homobasidiomycetes*. In: McLaughlin DJ, McLaughlin EG, Lemke PA (eds.), *The Mycota 7B, systematics and evolution*: 121–167. Springer: Berlin & Heidelberg.

- Holmgren PK, Holmgren NK, Barnett LC. 1990. Index Herbariorum. New York Botanical Garden: New York.
- Larsson KH. 2001. The position of *Poria mucida* inferred from nuclear ribosomal DNA sequences. Harvard Pap. Bot. 6: 131–138.
- Larsson KH, Larsson E, Kõljalg U. 2004. High phylogenetic diversity among corticioid homobasidiomycetes. Mycol. Res. 198: 983–1002.
- Lowe JL. 1966. *Polyporaceae* of North America, the genus *Poria*. State Univ. Coll. Forestry Techn. Publ. 90: 1–183.
- Miettinen O, Niemelä T, Spirin W. 2006. Northern *Antrodiella* species, the identity of *A. semisupina*, and type studies of related taxa. Mycotaxon 96: 211–239.
- Niemelä T. 1994. Five species of *Anomoporia*, rare polypores of old forests. Ann. Bot. Fennici 31: 93–115.
- Nylander JA. 2004. MrModeltest v2.2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.
- Pouzar Z. 1966. Studies in the taxonomy of the polypores 1. Česká Mykologie 20: 171–177.
- Rassi P, Alanen A, Kanerva T, Mannerkoski I (eds.). 2001. The 2000 Red List of Finnish species. Ministry of Environment & Finnish Environment Institute: Helsinki.
- Ronquist F. 2004. Bayesian inference of character evolution. Trends Ecol. Evol. 19: 475–481.
- Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 2003 19: 1572–1574.
- Ryvarden L, Gilbertson RL. 1993. European polypores 1, *Abortiporus* to *Lindtneria*. Synopsis Fungorum 6: 1–387.
- Swofford DL. 2003. PAUP*—phylogenetic analysis using parsimony (* and other methods). Version 4. Sinauer Associates: Sunderland, MA.
- Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. J. Bacteriol. 172: 4238–4246.
- White TJ, Bruns TD, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, White TJ (eds.), PCR protocols, a guide to methods and applications: 315–322. Academic Press: New York.
- Zander RH. 2004. Minimal values for reliability of bootstrap and jackknife proportions, decay index, and Bayesian posterior probability. Phyloinformatics 2: 1–13.

New data and localities for *Navisporus* in America

MABEL GISELA TORRES-TORRES^{1, 2*}, LAURA GUZMÁN-DÁVALOS²

* magitoto@yahoo.com, lguzman@cucba.udg.mx

¹ Universidad Tecnológica del Chocó, Ciudadela Medrano
Quibdó, Chocó, Colombia

² Departamento de Botánica y Zoología, Universidad de Guadalajara
Apartado postal 1-139, Zapopan, Jal., 45101, Mexico

LEIF RYVARDEN³

leifry@ulrik.uio.no

³ Botany Department, University of Oslo
P.O. Box 1045, Blindern, N-0316 Oslo, Norway

Abstract – The genus *Navisporus* is recorded for first time from Mexico, and the species *N. floccosus* is recorded for the first time from Mexico and Cuba. Based on study of the type specimen of *Ganoderma areolatum*, this species is synonymized under *N. floccosus*. Furthermore, *Navisporus sulcatus* is recorded from northern Brazil.

Key words – Polyporaceae, Basidiomycota, taxonomy

Introduction

Navisporus Ryvar den (*Polyporaceae*) (Ryvar den & Johansen 1980) is characterized by its dextrinoid skeletal hyphae and navicular basidiospores. It is a relatively small genus, with six species described, and mainly with a pantropical distribution (Ryvar den 1991). The majority of the species are poorly known, with a very restricted distribution. Four species have been described from the Neotropics: *Navisporus floccosus*, *N. sulcatus*, *N. perennis* Ryvar den & Iturr. and *N. terrestris* Gibertoni & Ryvar den, and two from the Paleotropics: *N. africanus* Ryvar den and *N. ortizii* S. Herrera & Bondartseva (Ryvar den & Iturriaga 2003, Gibertoni et al. 2004). Of these species, two are recently described and known only from their type localities: *N. perennis* from Venezuela (Ryvar den & Iturriaga 2003) and *N. terrestris* from Brazil (Gibertoni et al. 2004). *Navisporus floccosus* has been recorded from North America, Africa and Asia (Ryvar den & Johansen 1980) and *N. sulcatus* was cited from Florida (Gilbertson & Ryvar den

1986) and southern Brazil (Rajchenberg & Meijer 1990). The genus has not previously been recorded from Mexico.

In the course of *Ganodermataceae* studies from tropical America, the type specimen of *Ganoderma areolatum*, deposited at NY, was checked. This material has morphological features different from *Ganoderma*. Currently, *Ganoderma* is divided in two subgenera: *Ganoderma* and *Elfvigia*. Subgenus *Ganoderma* is characterized by having a glossy cuticle formed by cuticle cells; in contrast, in subgenus *Elfvigia* the crust is opaque, and does not present differentiated cells. *Ganoderma areolatum* was placed in the subgenus *Ganoderma* (Moncalvo & Ryvardeen 1997) and was treated as a synonym of *G. resinaceum* Boud. (Ryvardeen 1985), also in subgenus *Ganoderma*.

Materials and methods

The material studied was requested to ENCB, NY and O herbaria; the new collection made in Mexico was deposited in IBUG. Descriptions of the basidiomata were made according to the following macro features: basidioma size, substrate adhesion, pileus color, consistency; tubes stratification, length, color, pores per mm, pore surface color; context stratification, width, color. The color was described using the key colors of Kornerup & Wanscher (1978). Micromorphological observations were made from material mounted in 5% KOH and Melzer's reagent; measures were made in 5% KOH. Basidiospore shape was determined according to Q coefficient (length-width, Bas 1969) of 20 randomly selected basidiospores. Herbarium abbreviations follow Holmgren et al. (1990).

Taxonomy

The genus *Navisporus* is reported for the first time from Mexico. *Navisporus floccosus* is recorded from Mexico and Cuba. *Navisporus sulcatus*, an apparently rare species, is recorded from northern Brazil. The type specimen of *Ganoderma areolatum* has morphological features different from *Ganoderma*; here it is synonymized under *Navisporus floccosus*.

From the two species considered, only *Navisporus floccosus* is described in detailed, both macro and micromorphologically, while *N. sulcatus* is described only micromorphologically.

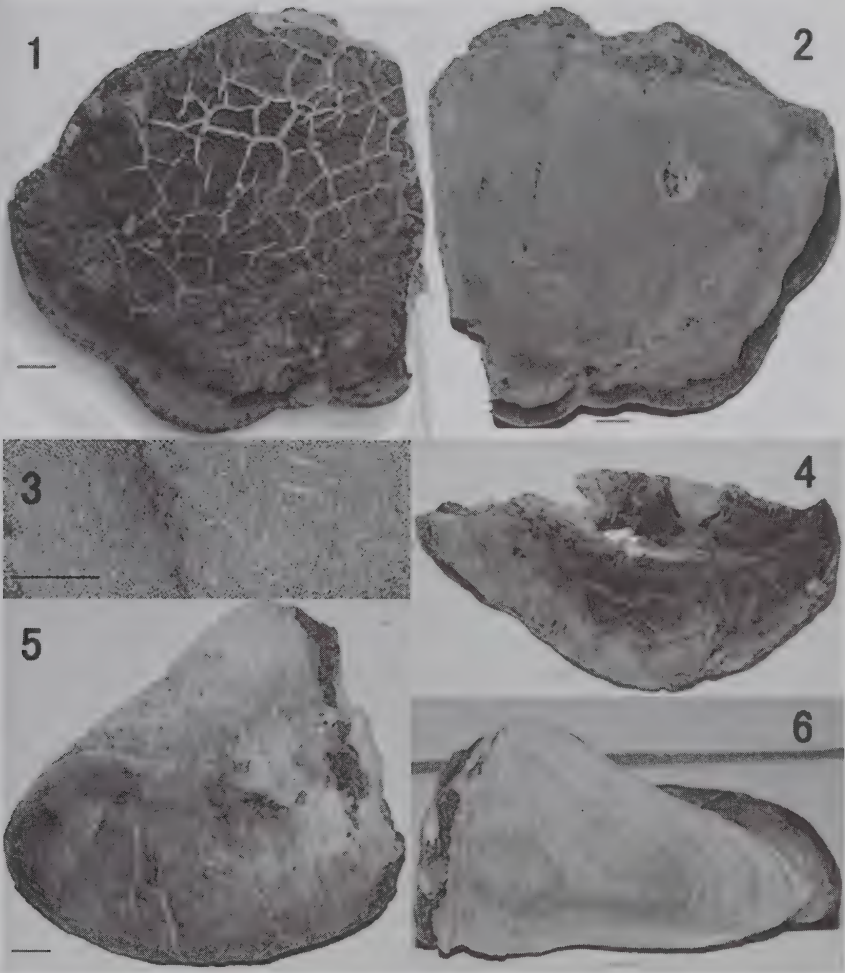
Navisporus floccosus (Bres.) Ryvardeen

Figs. 1-10, 13-16

in Ryvardeen & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 443, 1980.

≡ *Trametes floccosa* Bres., Ann. Roy. Inst. Bot. Roma 6: 179, 1896.

= *Ganoderma areolatum* Murrill, Bull. New York Bot. Gard. 8: 149, 1912.



Figs. 1-6. *Navisporus floccosus*. 1-2: Basidiomata of *Ganoderma areolatum* (holotype), 1: pileus, 2: pore surface, 3-4: basidiomata (L. Guzmán-Dávalos 9904), 3: pore surface, 4: pileus, 5-6: basidiomata (J. Pérez-Ortiz 1016), 5: pileus, 6: context. Scale bar = 1 cm, except 3 = 3 cm.

Basidiomata 20-35 x 13-20 x 5.5-7 cm, annual, sessile, broadly attached, single, soft-corky, light weighted, context thinner than tubes. **Pileus** rounded flabelliform, convex; surface glabrous, smooth, dull, without zonation; with a distinctive crust in old specimens, wrinkled, up to 0.5 mm thick; first cream (4A3) darkening to mandarin-orange (6B8) when bruised, grayish-brown (13F) to almost black in adult or old specimens; margin thin to thick, at times rounded, even, cream to grayish-brown. **Context** averaging 2-4 cm thick, up to

7 cm thick at the base, soft, zonate, orange-white (5A2) to pale orange (5A3), darker near the tubes, dark chestnut (6F7), without resinous substance. **Pores** 2-3 per mm, generally irregular; pore surface pale yellow (4A3), darker when bruising or aging; tubes 2.5-4 cm long, concolorous with pore surface. KOH: pileus black; context, tubes and pore surface blackish-brown.

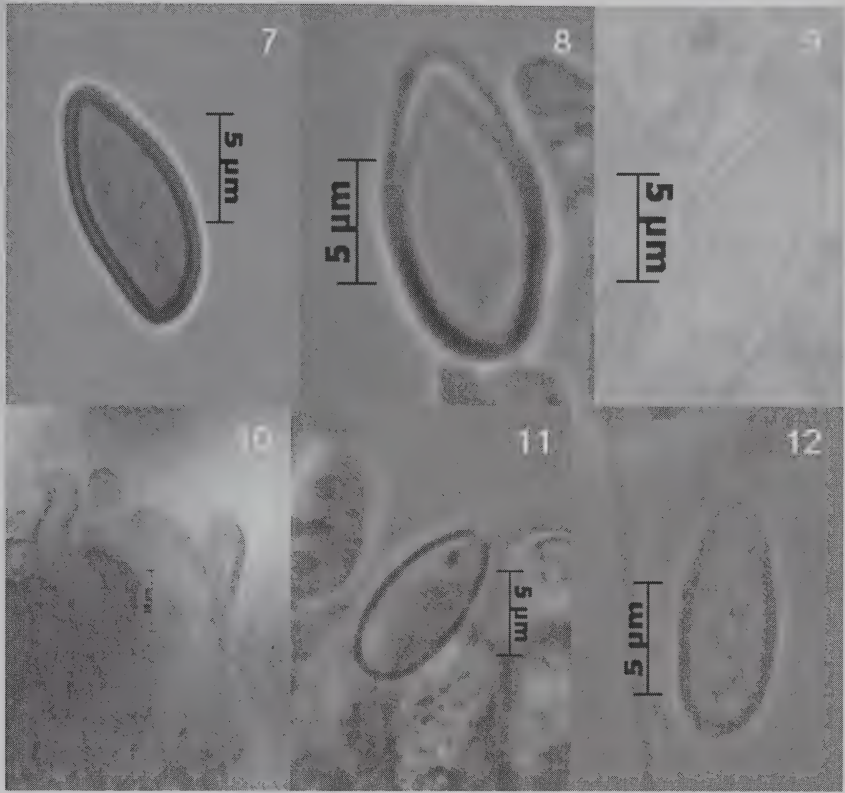
Contextual trama with dimitic hyphal system; generative hyphae scarce and collapsed, thin-walled, with conspicuous clamps, yellowish, difficult to observe; skeletal hyphae 1.6-14.4 μm diam., thick-walled (0.4-2.4 μm), non-septate, generally unbranched to moderately branched, yellowish to yellow, dextrinoid. **Hymenophoral trama with dimitic hyphal system**; generative hyphae 2.4-2.8 μm diam., thin-walled, with conspicuous clamps, yellowish, scarce, difficult to observe; skeletal hyphae up to 6.4 μm diam., thick-walled, non-septate, sometimes branched, yellowish to yellow, slightly dextrinoid to dextrinoid. **Pileus crust** when present formed by erect and rounded apex hyphae as a palisoderm; generative hyphae 3.2-6.4 μm diam., thin-walled to sclerified, with conspicuous clamps, single or multiple, generally branched, hyaline to yellowish, abundant, forming a compact network; skeletal hyphae 4.5-9.6 μm diam., thick-walled (0.8-4 μm), unbranched to branched, yellow to brown-amber, with granulose content, some septate toward apex and constricted; sclerids present. **Basidiospores** 11.2-13.6 x 5.6-7.2 μm , $Q = 1.76$ -2.29, oblong to cylindrical, amygdaliform to subcylindrical, with the apical side acute to subacute, without germ pore, smooth, with conspicuous lateral apicule, yellowish to golden-yellow; thick-walled (up to 1 μm), negative in Melzer's reagent. **Basidia** approximately 18.4 x 5.6 μm , clavate, hyaline to yellowish, tetrasporated, scarce. **Cystidia** or other sterile hymenial elements not observed.

Substrata - On a dead trunk of a silk-cotton tree, on a living trunk of *Ficus*, and on an unidentified stump, according to the specimens examined.

Habitat - Secondary tropical forests.

Specimens studied - CUBA, Province of La Habana, Escaleras de Jaruca, 16 June 2001, C. Decock s.n. (O). MEXICO, Colima, near Colima, January 1910, W.A. Murrill & E.L. Murrill 588 (NY, Holotype of *Ganoderma areolatum*); Jalisco, Municipality of Puerto Vallarta, Hotel NH-Kristal, alt. 5 m, 28 October 2005, L. Guzmán-Dávalos 9904 (IBUG); Veracruz, Municipality of Minatitlán, El Remolino, Río Coachapa, 7 August 1977, J. Pérez-Ortiz 1016 (ENCB).

Remarks - The studied specimens coincide with Ryvarden (2004), except that this author described basidiospores slightly different (12-15 x 4.5-6.5 μm) and hyaline; in our case only the immature basidiospores were hyaline. The material L. Guzmán-Dávalos 9904 developed a very thick and black crust over some parts of the pileus; while in the type specimen of *Ganoderma areolatum*



Figs. 7-12. 7-10: Microscopic features of *Navisporus floccosus*. 7-9: basidiospores; 7: holotype of *Ganoderma areolatum*, 8: specimen J. Pérez-Ortiz 1016, 9: specimen L. Guzmán-Dávalos 9904; 10: elements from the crust of *Ganoderma areolatum* (holotype), sclerified generative hyphae. 11-12. *Navisporus sulcatus*, basidiospores (G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n.).

the cuticle is almost uniform over all the pileus. The specimen J. Pérez-Ortiz 1016 does not present this cuticle; moreover it has a very thick margin. Our guess is that the old materials might develop a thick and black cuticle, similar to *Ganoderma* and *Fomes*. In all cases, the Mexican materials studied here were confused with *Ganoderma*. Nevertheless, the macromorphological features that make them different from *Ganoderma* are the irregular, thinner walled and bigger sized pores in *N. floccosus*. Although, *N. floccosus* has black cuticle, pale context and spongy basidiomata as do some of the temperate species of *Ganoderma* (i.e. *G. carnosum* Pat., *G. oregonense* Murrill, *G. tsugae* Murrill and *G. valesiacum* Boud.), these have a peculiar shiny basidiomata and a more fragile cuticle.

The type material of *Ganoderma areolatum* presents remarkable features different from subgenus *Ganoderma*. First of all, *Ganoderma* has basidiospores double-walled, with inter-walled pillars and apical germ pore. The crust in *G. areolatum* is not formed by cuticle cells, but by skeletal hyphae as in subgenus *Elfvingia*. However, in *Elfvingia* the skeletal hyphae are arboriform. After a bibliographical review (Murrill 1912, Corner 1983, Gilbertson & Ryvarden 1986, Núñez & Ryvarden 2000, Ryvarden 2000) and the study of specimens of *Navisporus*, we concluded that the type specimen corresponds with *N. floccosus*, meaning *G. areolatum* is a synonym of *N. floccosus*.

Ryvarden & Johansen (1980) and Gilbertson & Ryvarden (1986) described the basidiospores as fusoid or navicular. In the studied materials, we observed that the basidiospores have only the apical side subacute or acute; this was also observed in the specimen of *N. sulcatus*.

Navisporus sulcatus (Lloyd) Ryvarden,
Nordic J Bot. 3(3): 412, 1983.

Figs. 11-12, 17-19

≡ *Trametes sulcata* Lloyd, Mycol. Writ. 7: 1146, 1922.

The macroscopic features of *Navisporus sulcatus* are as described by Gilbertson & Ryvarden (1986).

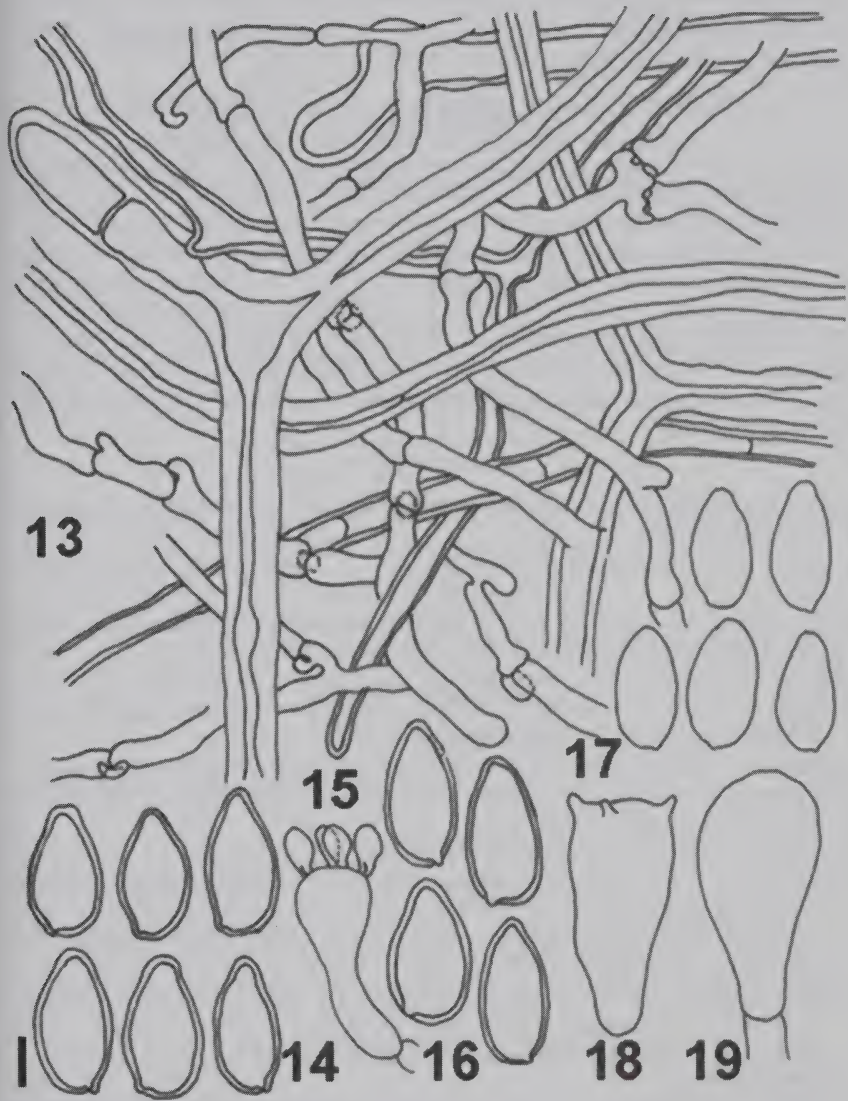
Contextual trama with dimitic hyphal system; generative hyphae scarce and collapsed, thin-walled, with conspicuous clamps, yellowish, difficult to observe; skeletal hyphae 2.4-5 µm diam., thick-walled (0.4-2.4 µm), non-septate, generally unbranched to moderately branched, yellowish to yellow, dextrinoid. **Hymenophoral trama with dimitic hyphal system;** generative hyphae 2.4-2.8 µm diam., thin-walled, with conspicuous clamps, yellowish, scarce, difficult to observe; skeletal hyphae up to 4 µm diam., thick-walled, non-septate, sometimes branched, yellowish to yellow, dextrinoid. **Basidiospores** 9-11.6 x 4.4-6.2 µm, $Q = 1.82-2.82$, oblong to cylindrical, amygdaliform to subcylindrical, with the apical side acute to subacute, without germ pore, smooth, with conspicuous apicule, yellowish to golden-yellow; thick-walled (up to 1 µm), negative in Melzer's reagent. **Basidia** 20-20.6 x 8.8-9 µm, clavate, hyaline to yellowish, tetrasporated, abundant. **Cystidia** or other sterile hymenial elements not observed.

Substrata - On *Manihot*.

Habitat - Tropical forest.

Specimen studied. Brazil, State of Roraima, Municipality of Boa Vista, Território do Roraima, vicinity of Auais, 800 m, 31 July 1974, G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n. (O).

Remarks - The studied specimen coincides with Gilbertson & Ryvarden (1986) and with Gibertoni et al. (2004), except that in this material the duplex context



Figs. 13-19. 13-16: Microscopic features of *Navisporus floccosus*. 13-15: holotype of *Ganoderma areolatum*; 13: elements from the crust, 14: basidiospores, 15: basidium. 16: basidiospores (J. Pérez-Ortiz 1016). 17-19. Microscopic features of *Navisporus sulcatus* (G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n.); 17: basidiospores, 18: basidium, 19: basidiolium. Scale bar = 4 μ m.

is not very evident. The species was recorded from south Brazil, State of Paraná (Rajchenberg & Meijer 1990), but no details about its morphological features and ecology were provided. Because of its morphological features the species may be confused with *Coriolopsis*, *Fomes* or *Trametes*, among many others; maybe this confusion is one of the reasons of its rarity.

Acknowledgments

Adriana de Mello Gugliotta from Instituto de Botânica da Secretaria de Estado do Meio Ambiente, São Paulo and Gastón Guzmán from Instituto de Ecología, Xalapa, kindly reviewed the manuscript. We are grateful to the curators of NY, O and ENCB, who kindly proportioned the materials from the study. Thanks are due to Universidad de Guadalajara (projects 34961 and 62935 from CA-23, and Fondos Concurrentes), CONACYT (project CONACYT-SEP-2003-C02-42957) and PROMEP (project 103.5/03/2580). The first author thanks Oslo University for a grant to visit O herbarium. She also thanks COLCIENCIAS and Universidad Tecnológica del Chocó for economic help for her Doctoral studies and to Dr. G. Guzmán for his support in the first steps in her studies in fungi.

Literature cited

- Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. *Persoonia* 5: 285-579.
- Corner EJH. 1983. Ad Polyporaceas I, *Amauroderma* and *Ganoderma*. *Beih. Nova Hedwigia* 75: 1-182.
- Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Studies in neotropical polypores 18. New species from Brazil. *Synopsis Fungorum* 18, Fungiflora, Oslo.
- Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol 1. Fungiflora, Oslo.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I. The herbaria of the world. 8th edition. New York Botanical Garden, New York. 663 pp.
- Kornerup A, Wanscher JH. 1978. *Methuen handbook of colour*. 3rd ed. Eyre Methuen, London.
- Moncalvo JM, Ryvarden L. 1997. A nomenclatural study of *Ganodermataceae* Donk. *Synopsis Fungorum* 11, Fungiflora, Oslo.
- Murrill WA. 1912. *Polyporaceae* of Mexico. *Bull. New York Bot. Gard.* 8: 137-153.
- Núñez M, Ryvarden L. 2000. East Asian Polypores. Vol 1 *Ganodermataceae* and *Hymenochaetaceae*. Fungiflora, Oslo.
- Rajchenberg M, Meijer AAR de. 1990. New and noteworthy polypores from Paraná and São Paulo States, Brazil. *Mycotaxon* 38: 173-185.
- Ryvarden L. 1985. Type-studies in *Polyporaceae* 17. Species described by W.A. Murrill. *Mycotaxon* 23: 169-198.
- Ryvarden L. 1991. Genera Polypores. Nomenclature and taxonomy. *Synopsis Fungorum* 5. Fungiflora, Oslo.
- Ryvarden L. 2000. Studies in Neotropical polypores 2: a preliminary to Neotropical species of *Ganoderma* with a laccate pileus. *Mycologia* 92: 180-191.
- Ryvarden L. 2004. Neotropical polypores part 1. *Synopsis Fungorum* 19, Fungiflora, Oslo.
- Ryvarden L, Iturriaga T. 2003. Studies in neotropical polypores 10. New polypores from Venezuela. *Mycologia* 95: 1066-1077.
- Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo.

**Anamorphic fungi from submerged plant material:
Phaeomonilia pleiomorpha, *P. corticola*
and *Cacumisporium pleuroconidiophorum***

RAFAEL F. CASTAÑEDA RUIZ

rfcastaneda@inifat.co.cu

Instituto de Investigaciones Fundamentales en Agricultura Tropical “Alejandro de Humboldt”, Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

GABRIELA HEREDIA ABARCA

gabriela.heredia@inecol.edu.mx

*Instituto de Ecología, A.P. 63, Km 2.5,
Antigua carretera a Coatepec, Xalapa, Veracruz, México*

ROSA MARIA ARIAS

rosa.arias@inecol.edu.mx

*Instituto de Ecología, A.P. 63, Km 2.5,
Antigua carretera a Coatepec, Xalapa, Veracruz, México*

MASATOSHI SAIKAWA

saikawa@u-gakugei.ac.jp

*Department of Biology, Tokyo Gakugei University,
Nukuikita-machi, Koganei-shi, Tokyo 184-8501, Japan*

DAVID W. MINTER

d.minter@cabi.org

CABI, Bakeham Lane, Egham, Surrey, TW20 9TY, United Kingdom

MARC STADLER

marc.stadler@t-online.de

*University of Bayreuth, Dept. Mycology
Universitätstr. 30, D-95544 Bayreuth, Germany*

Abstract — *Phaeomonilia pleiomorpha* anam. gen. et sp. nov. found on a decaying petiole submerged in a stream in the “Los Tuxtlas” rainforest, Veracruz, Mexico is described and illustrated. It is distinguished by globose, unicellular, colorless conidia formed by “thallic” disarticulations of fertile branches on macronematous conidiophores and by a *Stylaspergillus* synanamorph which arises from the same vegetative hyphae. Following re-assessment of type material, *Phaeomonilia corticola* comb. nov. and *Cacumisporium*

pleuroconidiophorum comb. nov. are proposed. The *Antipodium* anamorph of *Ophionectria tricospora* is reported from submerged wood in Mexico.

Key words — freshwater fungi, systematics, tropical fungi, hyphomycetes

Introduction

During several expeditions in 2002 and 2006 through the “Los Tuxtlas” rainforest, Veracruz, Mexico and the “El Avila”, Caracas, Venezuela some anamorphic fungi were collected from plant material submerged in streams. One of these fungi showed remarkable differences from previously described hyphomycetes and is therefore described as a new genus and species. Other two species are recorded from fresh water for the first time.

Materials and methods

Samples of submerged plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dishes, in moist chambers at 25° C, in plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Aeration was supplied with a fan (Daytron) for 5 to 10 minutes at 45 minutes intervals. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of $\times 1000$.

Taxonomy

Phaeomonilia R.F. Castañeda, Heredia & R. M. Arias anam. gen. nov.

MYCOBANK MB 510699.

Fungus anamorphicus pertinens. Coloniae effusae, brunneae usque ad nigrae. Conidiophora mononematosa, conspicua, plus minusve dichotome ad apicem ramosa, septata, brunnea usque ad atrobrunnea. Secessio conidiorum schizolytica. Ramoconidia et conidia “thallica-arthrica”, catenulata, fertilium per disarticulationem ramorum moniliformium producta, globosa, ellipsoidea, doliiformia usque ad irregularia, unicellularia, hyalina. Synanamorpha ad genus Stylaspergillus similis, nonnumquam ipsis ex hyphis exoriens, conidiophoris cum macronematosi, mononematosi, ad apicem ramosis, brunneis et cellulis conidiogeni enterogenici, uniloculosi, determinatis, introrsum curvatis, lageniformibus usque ad subulatis indutis quae conidia producant acicularia, curvata, unicellularia, hyalina. Teleomorphosis ignota.

Etymology: Greek, *phao-*, meaning dark-colored; Latin, *-monilia*, referring to a hyphomycete genus (*Monilia*).

Species typica: Phaeomonilia pleiomorpha sp. nov.

Anamorphic fungi — **Colonies** effuse, brown to black. **Conidiophores** mononematous, differentiated, septate, mostly dichotomously branched towards the apex, brown to dark brown. **Conidial secession** schizolytic. **Ramoconidia** and **conidia** “thallic-arthric”, catenate, globose, ellipsoid, doliiform to irregular,

unicellular, colorless, formed by disarticulation of the conidiogenous branches. **Synanamorph** *Stylaspergillus*-like sometimes arising from the same vegetative hyphae, with macronematous, mononematous, brown conidiophores branched towards the apex. **Conidiogenous cells** enterogenous, unilocular, determinate, inwardly curved, lageniform, to subulate. **Conidia** acicular, curved, unicellular, colorless. **Teleomorph** unknown.

Comments: *Phaeomonilia* is somewhat similar to *Botryomonilia* Goos & Piroz. (Goos & Pirozynski 1975) in its dichotomous branching system narrowing progressively towards the apex before the maturation and fragmentation or disarticulation process that produces the “thallic-arthric” conidia, as described by Kendrick (2003). *Botryomonilia*, however, has conidia connected by an isthmus. The two other similar genera are *Staheliella* Emden (Emden 1974) and *Oidiodendron* Robak (Ellis & Ellis 1997, Hambleton et al., 1998). In the former, the apical branching system is “narrower from inception and the initial branching is a cluster, although subsequent branching of the fertile hyphae is dichotomous” (Kendrick 2003), while the latter has an alternately penicillate to irregularly branching hyphal system. The new genus is distinct from both.

Phaeomonilia pleiomorpha R.F. Castañeda, Heredia & R. M. Arias,

anam. sp. nov.

Figs 1-10

MYCOBANK MB 510700

Coloniae effusae, funiculosae, brunneae. Mycelium plerumque superficiale et partim in substrato immersum, ex hyphis septatis, ramosis, 2.5–5.5 µm, brunneis vel atrobrunneis, laevibus compositum. Conidiophora mononematosa, usque ad 250 µm alta, 7–10 µm crassa ad basim, ad apicem dichotome ramosa, 2- ad 6-septata, ad basim brunnea, ad apicem pallidiora, levia. Ramoconidia et conidia “thallica-arthrica”, catenulata, per disarticulationem ramorum moniliformium fertiliū producta, globosa vel in forma plus minusve litterae Graecae upsilon, 4.0–5.8 × 3.9–4.4 µm, unicellularia, hyaline, levia, sicca. Synanamorpha cum conidiophoris macronematis, mononematis, 2- ad 3-septatis, compactis ramosis, 45–110 × 4–7 µm, brunneis, laevibus. Cellulae conidiogenae enterogae, uniloculosae, determinatae, introrsum curvatae, lageniformes usque subulatae, 11.0–12.7 × 4–5 µm. Conidia acicularia, curvata, 5.8–9.0 × 1.0–1.5 µm, unicellularia, hyalina. Teleomorphosis ignota.

Etymology: Greek, *pleio-*, meaning more than usual; *-morpha*, referring to existing forms of conidium ontogeny.

Colonies on the natural substratum effuse, funiculose, brown. **Mycelium** mostly superficial and partial immersed. **Hyphae** septate, branched, 2.5–5.5 µm, brown to dark brown, smooth. **Conidiophores** macronematous, mononematous, 2- to 6-septate, erect, straight or flexuous, more or less dichotomously branched towards the apex, up to 250 µm tall, 7–10 µm wide at the base, brown at the base, almost colorless towards the apex, smooth. **Ramoconidia** and **conidia** “thallic-arthric”, catenulate, globose, broadly Y-shaped, 4.0–5.8 × 3.9–4.4 µm, aseptate, colorless, dry, smooth, forming by disarticulation of the conidiogenous

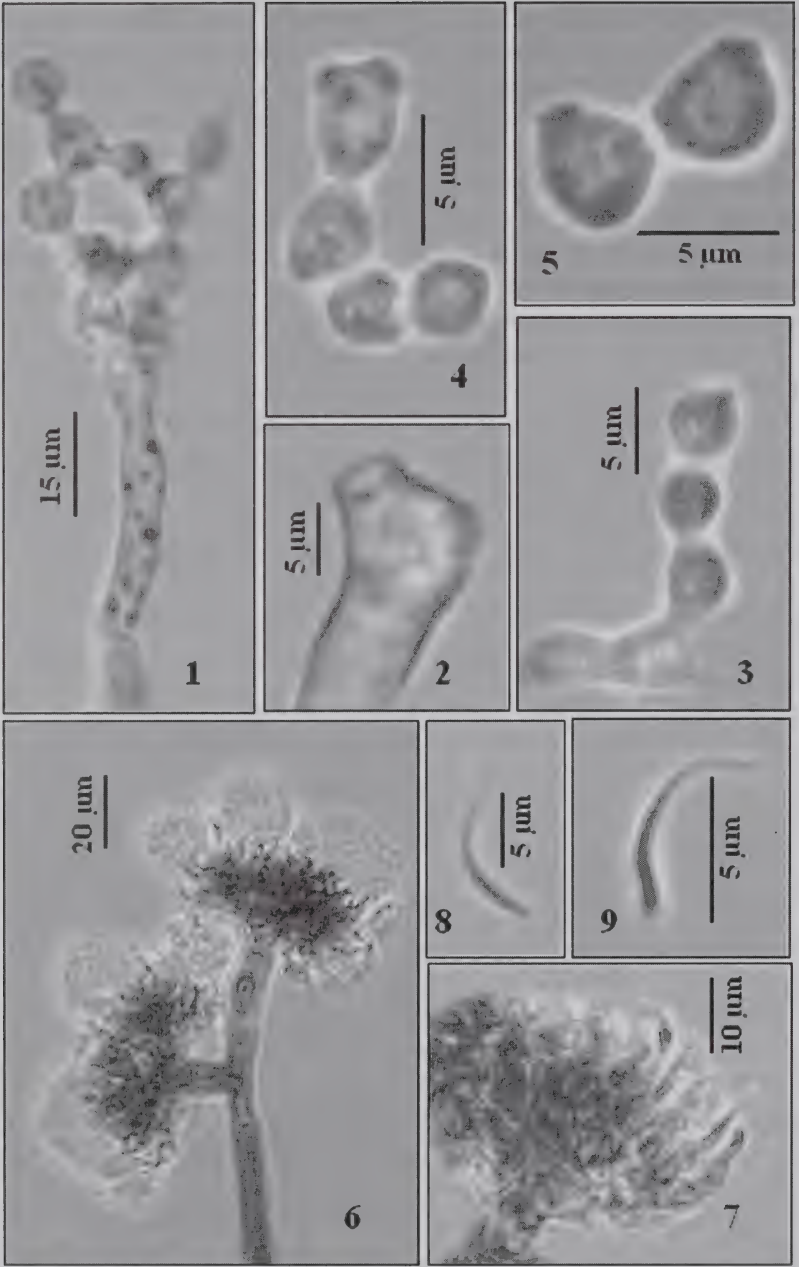


Fig. 1-9 *Phacomonilia pleiomorpha*, from holotype (XAL CB746). Fig. 1-3. Conidiophore, conidiogenous branches and catenulate thallic-arthric conidia. Fig.4,5. Conidia. Fig. 6-9. Synanamorph (*Stylaspergillus*-like).

branches. **Synnamorph** *Stylaspergillus*-like, arising from the same vegetative hyphae.

Conidiophores macronematous, mononematous, erect, straight, $45\text{--}110 \times 4\text{--}7\text{ }\mu\text{m}$, compactly multi-branched at the apex, brown, smooth. **Metulae** turbinate to doliiform, $5.5\text{--}6.5\text{ }\mu\text{m}$ wide. **Conidiogenous cells** enterogenous, unilocal, determinate, inwardly curved, lageniform, to subulate, $11.0\text{--}12.7 \times 4\text{--}5\text{ }\mu\text{m}$. **Conidia** acicular, curved, $5.8\text{--}9.0 \times 1.0\text{--}1.5\text{ }\mu\text{m}$, aseptate, colorless, smooth, accumulating in a white mass. **Teleomorph** unknown.

TYPUS: Mexico. Veracruz: "Los Tuxtlas", on the petiole of an unidentified palm tree submerged in a stream, 24.V.2002, coll. R.M. Arias and J.Y.C. Elizondo. **Holotype:** XAL CB746. **Isotype:** MUCL 45628

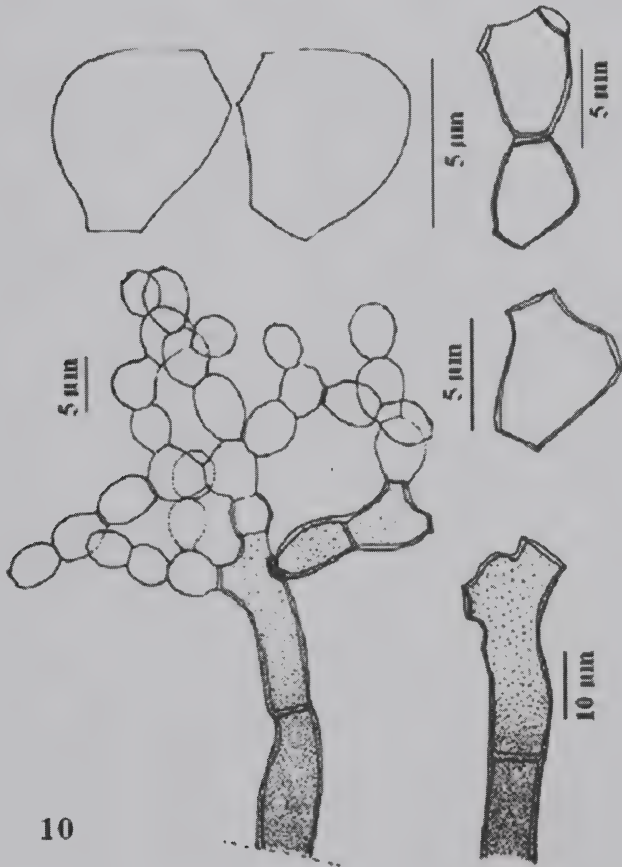


Fig.10. *Phaeomonilia pleiomorpha*, from holotype (XAL CB746).. Drawings of conidiophore, conidiogenous branches and conidia. Scale is indicated by bars.

Re-examination of material of *Monilia corticola* showed that it has aseptate, colorless, "arthric-thallic", doliiform, ellipsoid or Y-shaped conidia, $5.5\text{--}16.0 \times 4\text{--}5 \mu\text{m}$, formed by disarticulation of the apical fertile branches. All these characteristics are compatible with the new genus described above. A new combination is therefore proposed.

***Phaeomonilia corticola* (R.F. Castañeda) R.F. Castañeda, Saikawa & M. Stadler, comb. nov.**

MYCOBANK MB 510701.

Basionym: *Monilia corticola* R.F. Castañeda, in Deuteromycotina de Cuba. Hyphomycetes II. p. 11 (1985), Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", Cuba.

Specimen examined: INIFAT C84/146, on twig of *Bursera simaruba*, Sierra de Cubitas, Camagüey, Cuba, 29-XI-1984. Coll. R.F. Castañeda.

It was possible to identify several samples from decaying wood submerged in streams as *Pyriculariopsis pleuroconidiophora*. Ellis (1971) described the genus *Pyriculariopsis*, based on *P. parasitica* (Sacc. & Berl.) M.B. Ellis, and characterized by polyblastic, integrated, sympodial conidiogenous cells. This pattern of ontogeny was classified as conidial development type 10 (holoblastic, regularly alternating with sympodial proliferation, maturation by diffuse wall-building and secession schizolytic) in Hawksworth *et al.* (1995). Study of our samples of *P. pleuroconidiophora* showed that this fungus has conidiogenous cell development incompatible with the type of the genus.

Goos (1969) studied the conidiogenous cell development of *Cacumisporium capitulatum* (Corda) S. Hughes and found an unusual pattern of conidiogenesis with a combination of enteroblastic percurrent proliferation and sympodial holoblastic proliferation (development type 21, described as combination of events 10 and 19 in Hawksworth *et al.* 1995). The development observable in our samples of *P. pleuroconidiophora* is closely analogous to that described for *C. capitulatum*. The following new combination is therefore proposed.

***Cacumisporium pleuroconidiophorum* (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr., comb. nov. Figs. (11-19)**

MYCOBANK # MB 510702.

Basionym: *Pyriculariopsis pleuroconidiophora* Davydkina & Melnik, Mikologiya i Fitopatologiya 23 (2): 112 (1989).

Synonym: *Cacumisporium curvularioides* R.F. Castañeda & W.B. Kendr., Univ. of Waterloo Biol. Ser. 35: 16 (1991).

Specimens examined: XAL CB754-1 and XAL CB754-2, Mexico, Veracruz, on wood, 29.VII.2001, coll. G. Heredia, R.M. Arias, M. Reyes. INIFAT C06/36, Venezuela, Caracas, "El Ávila", ex wood submerged in a stream, 17.V.2006, coll. R. Fernández.

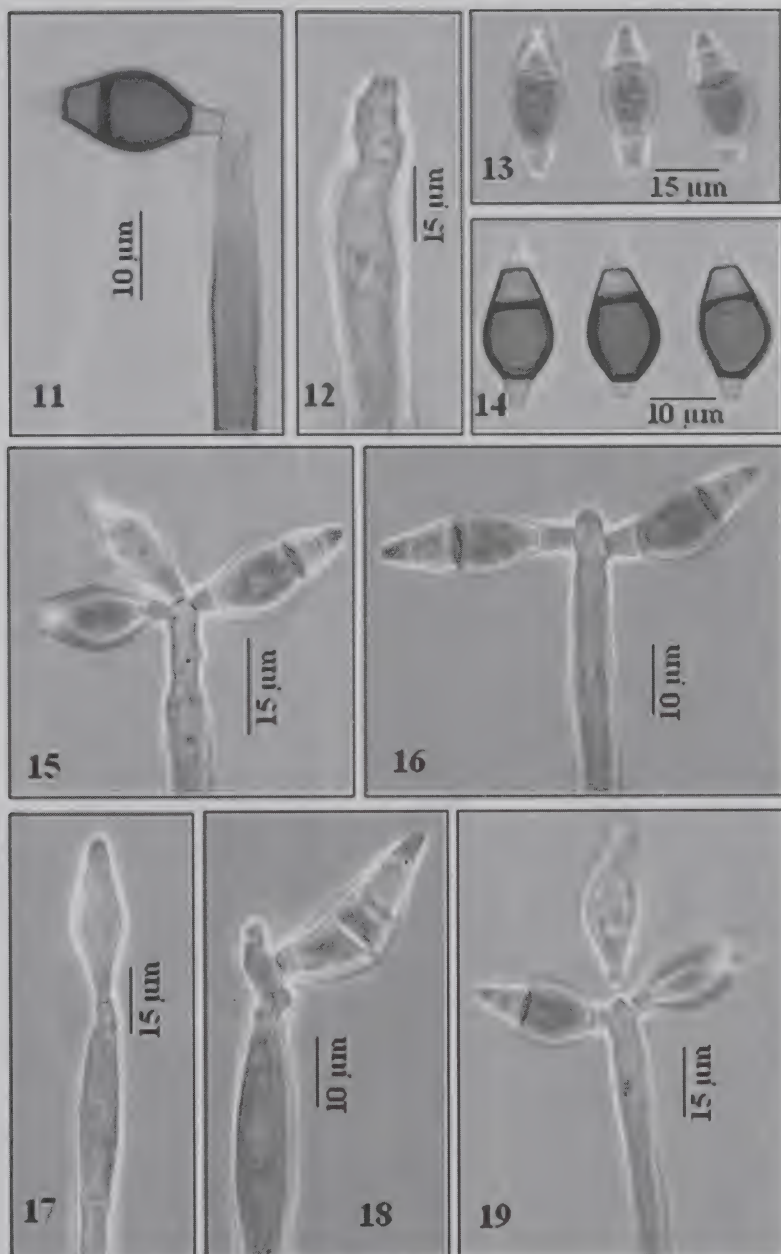


Fig. 11-19. *Cacumisporium pleuroconidiophorum*, from nature (XAL CB754-1 and INIFAT C06/36), Fig. 11, 12, 15-19 Details of conidiogenous cell proliferation and conidia. Fig. 13, 14. Conidia. Scale is indicated by bars.

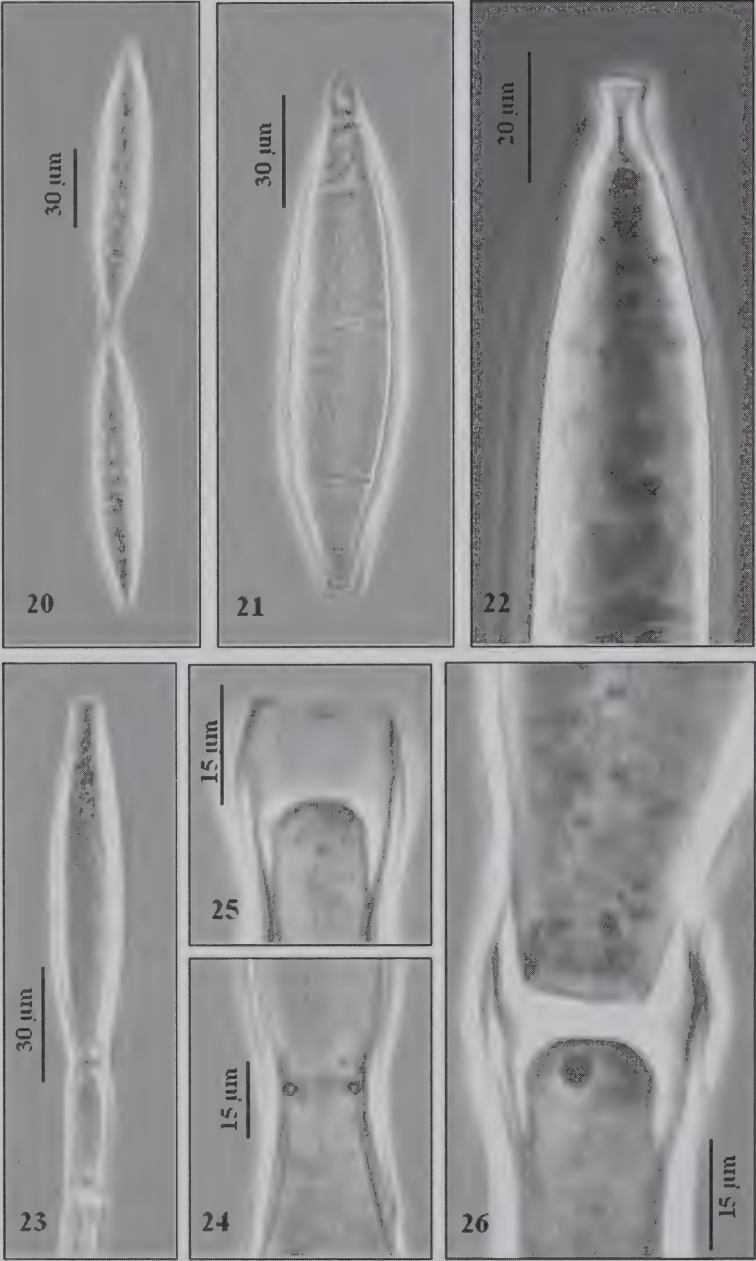


Fig. 20-26. *Antipodium spectabile*, from nature (XAL CB744). Fig. 20-22. Conidia. Fig. 23. Conidiogenous cell and conidia. Fig.24-26. Conidiogenous loci showing delimitation, conidial secession and collarette. Scale is indicated by bars.



Fig. 27 *Antipodium spectabile*, from nature (XAL CB744). Drawings of conidiophores, conidiogenous cells and conidia. Scale is indicated by bars.

Antipodium spectabile Piroz., Can. J. Bot. 52:1143 (1974).

Figs. (20–27)

Colonies on natural substratum hairy, effuse, white. **Mycelium** mostly immersed, composed of septate, branched, smooth, colorless hyphae, 2.0–4.5 μm diam. **Conidiophores** macronematous, mononematous, erect, straight or flexuous, 100–160 μm tall, 9–12 wide at the base, 3- to 6-septate, simple, smooth-walled, colorless. **Conidiogenous cells** enterogenous, unilocal, terminal, integrated, determinate, up to 40 μm long, 6.5–9.5 μm wide, colorless, with a conspicuous collarette at each conidiogenous locus, 7–9 μm wide, 5–6 μm deep. **Conidial secession** schizolytic. **Conidia** fusiform, 3- to 5-septate, (mostly 5-septate), basocatenate, truncate at the ends, or papillate to slightly obtuse at the apex, 95–128 $\times$ 21–29 μm , smooth, colourless.

Teleomorph: *Ophionectria trichospora* (Berk & Broome) Sacc., *Michelia* 1: 323 (1878).

Specimen examined: XAL CB744, Mexico, Veracruz, on wood submerged in a stream, 19.V.2002, coll. R.M. Arias and J. Y. C.Elizondo.

The above description, based on a specimen collected in nature, shows some differences in conidial morphology from the protologue of *Antipodium spectabile*, which was based on a pure culture derived from a single ascospore cultivated on PDA. Conidia in pure culture each have an apical cellular appendage or "foot-cell" (Pirozynski, 1974; Rossman et al., 1999), but only truncate or apically papillate conidia were observed by Subramanian & Bhat (1978) and in the specimen studied during the present work.

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Prof. Luis F. P. Gusmão (Universidade Estadual de Feira de Santana) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank R. Fernandez (Universidad Simón Bolívar, Caracas) for providing collected material. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. Part of the support for this work came from the UK Darwin Initiative.

Literature cited

- Castañeda Ruiz RF. 1985. Deuteromycotina de Cuba. Hyphomycetes II. Instituto de Investigaciones Fundamentales en Agricultura tropical "Alejandro de Humboldt", Havana, Cuba, 23 pp.
- Davydkina TA, Mel'nik VA. 1989. Two new hyphomycetes from the genera *Cordana* and *Pyrulariopsis*. Mikol. Fitop. 23 (2): 110-113. [in Russian]
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, 608 pp.
- Ellis MB, Ellis JP. 1997. Microfungi on Land Plants. An Identification Handbook. Enlarged Edn, 868 pp., Slough: Richmond Publishing.
- Emden van JH. 1974. *Staheliella*, a new genus of *Hyphomycetes* from tropical soil. Acta Bot. Neerl. 23: 251-256.
- Goos RD. 1969. Conidium ontogeny in *Cacumisporium capitulatum*. Mycologia 61: 52-56.
- Goos RD, Pirozynski KA. 1975. Fungi of Barro Colorado Island: new and interesting hyphomycetes. Can. J. Bot. 53: 2927-293
- Hambleton S, Egger KN, Currah RS. 1998. The genus *Oidiodendron*: species delimitation and phylogenetic relationships based on nuclear ribosomal DNA analysis. Mycologia 90 (5): 854-869.
- Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth & Bisby's, Dictionary of the fungi, eighth edition. International Mycological Institute, Kew, Surrey, 616 pp.
- Kendrick WB. 2003. Analysis of morphogenesis in hyphomycetes: new characters derived from considering some conidiophores and conidia as condensed hyphal systems. Can. J. Bot. 81: 75-100.
- Pirozynski KA. 1974. *Antipodium*, a new genus of Hyphomycetes. Can. J. Bot. 52: 1143-1146.
- Rossman AY, Samuels GJ, Rogerson CT, Lowen R. 1999. *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). Stud. Mycol. 42: 248 pp.
- Subramanian CV, Bhat DJ. 1978. Conidium ontogeny and ascus development in *Ophionectria trichospora*. Kavaka 6: 55-63.

Endococcus variabilis,
a new species on *Staurothele areolata*

MEHMET GÖKHAN HALICI¹, JANA KOCOURKOVÁ²,
PAUL DIEDERICH³ & AHMET AKSOY⁴

¹mghalici@erciyes.edu.tr ⁴aksoy@erciyes.edu.tr
Erciyes University, Fen Edebiyat Fakültesi, Biyoloji Bölümü
38039 Kayseri, Turkey

²jana_kocourkova@nm.cz
National Museum, Václavské nám. 68
115 79 Praha, Czech Republic

³paul.diederich@education.lu
Musée national d'histoire naturelle
25 rue Munster, L-2160 Luxembourg

Abstract—*Endococcus variabilis* is described as a new species from the thallus of *Staurothele areolata* in Turkey and Austria. It differs from most other species of the genus in the 4–6(–8) spored asci and verrucose ascospores, from *E. zahlbrucknerellae* in ascomatal and ascospore size, and from all known species by the host selection.

Key words—lichenicolous fungi, *Dothideales*, *Ascomycota*

Introduction

The genus *Endococcus* comprises at least 37 species occurring on a wide range of crustose, foliose, and fruticose lichens. The species have been revised by Hawksworth (1979) and Triebel (1989, only lecideicolous species), but many others have been recognized since those works. Recent collections from Turkey and Austria of a species on *Staurothele areolata* differ significantly from previously described taxa and are described here as a new species.

Material and methods

The type specimen of the new species is deposited in ANES. It was examined by standard microscopic techniques, and drawings were made using a drawing tube. Sections were prepared by hand and examined in Congo red (1% solution in water, mixed 1:1 with 10% KOH), I (Lugol's iodine: I 0.5 g, KI 1.5 g, water

100 ml), 10% KOH, and water. Amyloid reactions were tested using Lugol's iodine solution (I) without and with pre-treatment by KOH (K/I). Ascus structures were examined and drawn in Congo red after pre-treatment with KOH. Ascospore measurements were made in water; extreme values are given in parentheses. Ascospore measurements are indicated as (minimum-) $\bar{x} - \sigma_x - \bar{x} + \sigma_x$ (-maximum), followed by the number of measurements (n); the length/breadth ratio of ascospore is indicated as l/b and given in the same way.

The species

Endococcus variabilis Halici, Kocourk. & Diederich, sp. nov.

FIGURES 1-2

MYCOBANK MB 510682

Fungus lichenicola in thallus lichenis Staurothele areolata vigens. Endococcus species insignis ascomatibus immersis vel semi-immersis, subsphaericis ad subpyriformibus, atris, 230–260 μm altis, 190–250 μm latis, pariete pallide brunneo sed apicaliter atrobunneo, K+ viridulo, 20–25 μm crasso, apicaliter 40 μm crasso, hamathecio sine paraphysibus, periphysibus 30–36 μm longis, 3.5–5.5 μm latis, centro I+ dextrinoideo, K/I+ coeruleo, ascis clavatis ad subcylindricis, 4–6(–8)-sporis, 47–60 $\times$ 13.5–18.5 μm , parietate apicaliter incrassato, ascosporis auratobrunneis, 1-septatis, verruculosis, cum perisporo 0.5 μm crasso, (11.0–)13.0–16.0(–18) $\times$ (5.5–)6.5–7.5(–8.5) μm .

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Karaboyunlar Mevkii, 37°52'N, 35°15'E, alt. 2795 m, on thallus of *Staurothele areolata* on exposed limestone rocks, 25 August 2006, M.G.Halici 0.2290 (ANES–holotypus).

Etymology: The epithet “*variabilis*” refers to the variable number of ascospores, usually 4 to 6, developing in the asci.

Description: Lichenicolous fungus growing on the areoles of the host thallus *Staurothele areolata*, suppressing host ascomatal production in infected areoles. **Ascomata** perithecioid, arising singly, sometimes aggregated in loose groups, immersed to erumpent, subglobose to obpyriform, upper part more or less applanate, with a broad ostiolar part up to 25 μm , black, somewhat shiny, 230–260 μm tall, 190–250 μm wide; wall mainly 25–35 μm thick, pseudoparenchymatous, formed of radially compressed polyhedral cells, dark brown near ostiole, basally to subapically subhyaline to pale brown, K+ greenish, c. (5–)7–9 cells thick, cells thin-walled, 6–10 $\times$ 2.5–4 μm in vertical section. **Hamathecium** of periphysoids, lining the ostiolar canal and spreading down to upper 1/5 of the ascoma, around the ostiolar part pale brown, beneath hyaline, simple or branched near the base, of 4–5 thin-walled cylindrical to broadly cylindrical cells 7–10(–15) $\times$ 3.5–5.5 μm diam, 30–36 μm long; central cavity formed of gelatinized tissue and the remains of discharged asci, hymenial gel hemiamyloid, I+ orange, K/I+ blue. **Asci** arising from the basal and side parts of the ascomatal cavity, lining a substantial part of the inner wall of ascomatal cavity, clavate to subcylindrical, sessile to shortly stalked, mostly without distinct

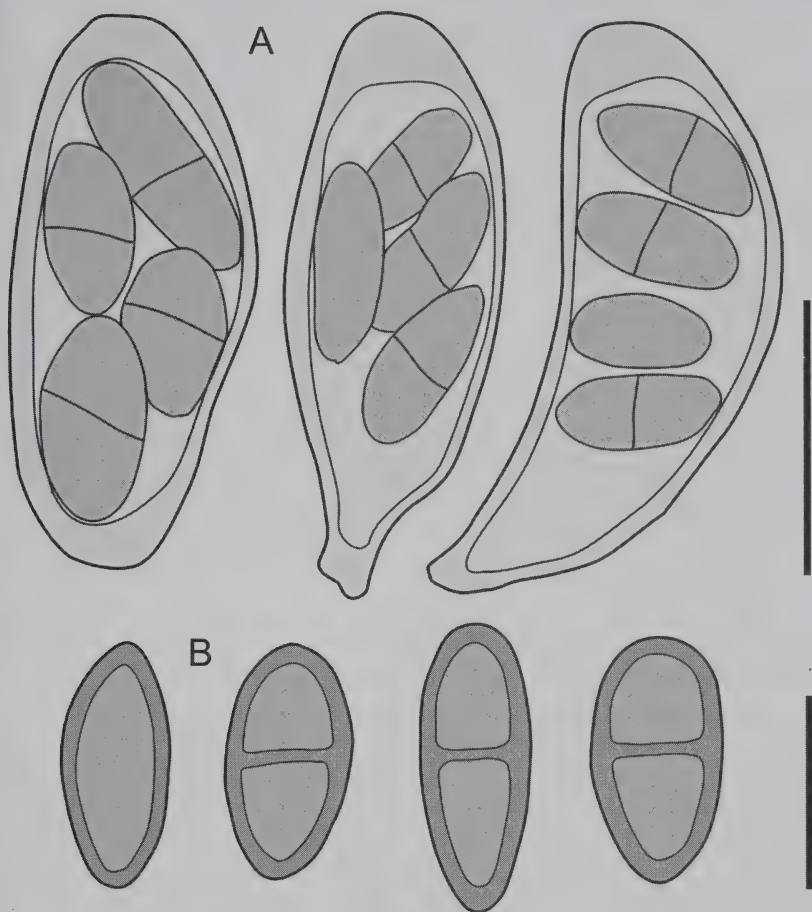


Fig. 1. *Endococcus variabilis* (holotype). A, asci in Congo red after pre-treatment with KOH. B, ascospores. Scales A = 20 μ m, B = 10 μ m.

internal apical beak, 4–6(–8)-spored, $47\text{--}60 \times 13.5\text{--}18.5 \mu\text{m}$, fissitunicate, K/I+ blue. **Ascospores** uniseriate or distichously arranged in the asci, ellipsoid to slightly fusiform, golden brown, simple when young, becoming 1-septate when mature, not or slightly constricted at the septum, some with one or two big oil droplets, golden brown, pigment somewhat concentrated at the slightly thickened apices and septum, the outermost layer faintly verruculose, $0.5\text{--}1 \mu\text{m}$ thick, the septum of the same thickness ($0.5\text{--}1 \mu\text{m}$), the gelatinous, thin, perispore $0.5 \mu\text{m}$ thick, $(11.0\text{--})13.0\text{--}16.0\text{--}(18) \times (5.5\text{--})6.5\text{--}7.5\text{--}(8.5) \mu\text{m}$ ($n=40$), length/breadth ratio $(1.6\text{--})1.8\text{--}2.4\text{--}(2.1) \mu\text{m}$. **Conidiomata** not observed.

Additional specimen examined: Austria, Steiermark, Ostalpen, Niedere Tauren, Schladminger Tauern, WSW of Schladming, eastern overhangs of mountain range between Gasselhöhe and Rippetegg, path to Mittersee, MTB 8647/2, alt. 1820 m, on mineral rich calcareous mica schist, on thallus of *Staurothele areolata*, 26 August 2001, J. Kocourková (PRM 895949).

Discussion

Following Triebel (1989), *Endococcus* specimens with ascospores similar in size to our new species belong to *E. rugulosus* Nyl. 1855. However, this author used a very broad species concept, including under that name material from a wide variety of hosts belonging to at least seven genera. Recent studies (Brand, unpubl.; Sérusiaux et al. 1999, Kocourková 2000) suggest that *Endococcus* species are generally host-specific, and the name *E. rugulosus* should probably be restricted to specimens growing on *Verrucaria*. As the host of the new species, *Staurothele areolata*, is closely related to *Verrucaria*, both *Endococcus* species were carefully compared. Moreover, recently two additional *Endococcus* species were described from related host genera. *Endococcus incrassatus* Etayo & Breuss (Etayo & Breuss 2001) from *Placidiopsis cinerascens* and *E. karlstadtensis* Kocourk. & Brackel (Brackel & Kocourková 2006) from *Endocarpon pusillum*.

Apart from the different hosts, the new *Endococcus variabilis* differs from *E. rugulosus*, *E. incrassatus* and *E. karlstadtensis* in having 4–6(–8)-spored asci (versus constantly 8-spored), and substantially larger ascomata, mainly 230–260 × 190–250 µm, versus 90–220 µm diam in *E. rugulosus* and 100–120 µm in *E. incrassatus*. The ascospores of *E. variabilis* are (11.0–)13.0–16.0(–18) × (5.5–)6.5–7.5(–8.5) µm, distinctly verruculose and thick walled (wall c. 1 µm), larger than in *E. karlstadtensis* (8.5–)9.5–11.6(–12.7) × (4.9–)5.9–6.9(–7.5) µm, in which ascospores are pale brown for a long time and verruculose only when fully mature. The material on *Verrucaria* called *E. rugulosus* by Sérusiaux et al. (1999) has dark brown, also small and verruculose ascospores, 10–12(–12.5) × 5.5–7.5 µm that are thin walled (wall c. 0.5 µm); the material of *E. rugulosus* used for comparison in this study has also small ascospores, (8.5–)9.5–13.0(–15.5) × (5.0–)6.0–7.0(–8.0) µm. However, none of these authors studied the type specimen of *E. rugulosus*, and thus it is not entirely certain if they were dealing with the genuine *E. rugulosus*, or with a similar, undescribed species. Triebel (1989) gave the ascospores of *E. rugulosus* s. l. as smooth and (12–)13–16(–16.5) × (5.5–)6–7.5(–8) µm. In the holotype they are smooth and 12–15 × 6–9 µm (D. L. Hawksworth, pers. comm.).

With our current knowledge, *E. zahlbrucknerellae* (Henssen) D.Hawksw. 1979 is the only other known *Endococcus* species with 4-spored asci. That species differs in having much smaller ascomata (up to 100 µm diam), smaller ascospores (10.5–13.5 × 5.5–6 µm, fide Hawksworth 1979; 12–15 × 5–6 µm, fide

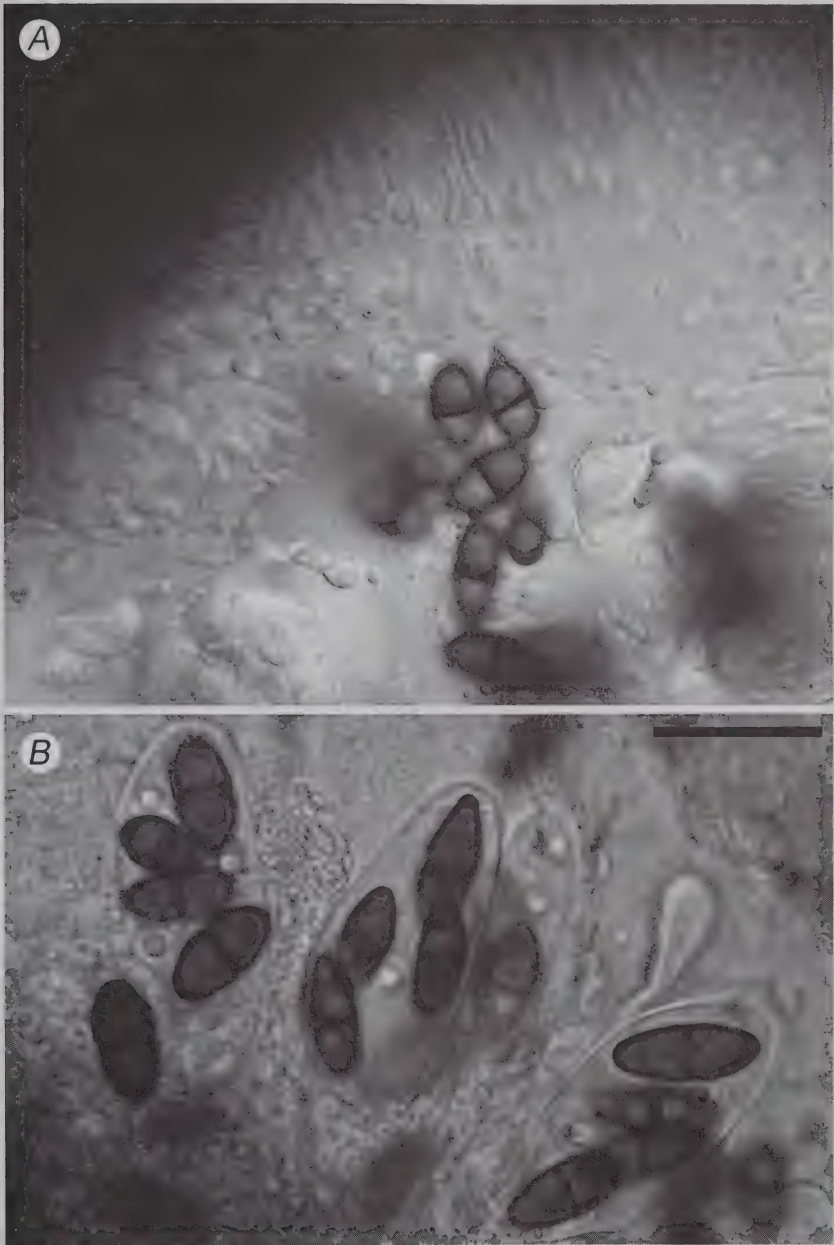


Fig. 2. *Endococcus variabilis*. A, section through a perithecium showing verruculose ascospores from one ascus and periphysoids (J. Kocourková, PRM 895949). B, 4-spored asci (holotype). Scale = 20 μm .

Henssen 1977), and the induction of distinct galls on a different host lichen, *Zahlbrucknerella calcarea*.

Hafellner (2002) reported the discovery of a specimen from the Canary Islands on *Acarospora* with 4-spored asci that he provisionally included in *Endococcus stigma*, a species with soleiform and apically often strongly attenuated ascospores.

Endococcus rugulosus specimens examined (All on *Verrucaria nigrescens*): CZECH REPUBLIC: Central Bohemia, Praha, between Velká Chuchle and Slivenec, 290 m, MTB 5952, Homolka calcareous rocks, 4 January 1994, J. Horáková (PRM 889662). - Praha, Nová Ves, 290 m, MTB 5952, Hemrovy skály diabasic rocks, 15 April 1999, J. Kocourková (PRM 758701). - Praha, near Nová Ves settlement in Prokopské valley, MTB 5952, 310 m, Bílé skály calcareous rocks, 24 September 1999, J. Kocourková (PRM 758700). - Praha, Prokopské údolí valley, 280 m, MTB 5952, calcareous rocks above old swimming pool Holyňské koupaliště, 10 April 1988, J. Horáková (PRM 758688).

SLOVAKIA: Carpathians, Spišské Podhradie, Sívá Brada hill, on calcareous sinter, 500 m, 21 May 1958, A. Vězda (PRM 515663; Vězda, Lich. Bohemosl. exs. no. 235, sub *Caloplaca lactea*).

Acknowledgements

David L. Hawksworth and Alan Orange are thanked for critically reviewing this paper. This study was supported by TUBITAK (105T175 coded project) and part of this study (J. Kocourková) was financially supported by the grant MK00002327201 from the Ministry of Culture of the Czech Republic. This study was finished when MGH was in the Facultad de Farmacia, Universidad Complutense de Madrid under the direction of David L. Hawksworth with a grant from TUBITAK.

Literature cited

- Brackel W von, Kocourková J. 2006. *Endococcus karlstadtensis* sp. nov. und weitere Funde von flechtenbewohnenden Pilzen in Bayern - Beitrag zu einer Checkliste II. Berichte Bayerische Botanische Gesellschaft 76: 5-32.
- Etayo J, Breuss O. 2001. *Endococcus incrassatus*, a new lichenicolous fungus (*Dothideales*). Österreichische Zeitschrift für Pilzkunde 10: 315-317.
- Hafellner J. 2002. Bemerkenswerte Funde von Flechten und lichenicolen Pilzen auf makaronesischen Inseln VI. Über einige Neufunde. Fritschiana 36: 11-17.
- Hawksworth DL. 1979. Studies in the genus *Endococcus* (*Ascomycotina*, *Dothideales*). Bot. Notiser 132: 283-290.
- Henssen A. 1977. The genus *Zahlbrucknerella*. Lichenologist 9: 17-46.
- Kocourková J. 2000 ["1999"]. Lichenicolous fungi of the Czech Republic. (The first commented checklist). Acta Musei Nationalis Pragae, Ser. B., Hist. Nat., 55[(3-4): 59-169.
- Sérusiaux E, Diederich P, Brand AM, van den Boom P. 1999. New or interesting lichens and lichenicolous fungi from Belgium and Luxembourg. VIII. Lejeunia NS 162: 1-95.
- Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1-278.

***Fibricium gloeocystidiatum*
(Polyporales, Basidiomycetes), new to Europe**

LUIGI ARRAS¹, ANDREA PIGA²,
ANNAROSA BERNICCHIA³ & SERGIO PÉREZ GORJÓN⁴

¹luigi.arras@alice.it ³annarosa.bernicchia@unibo.it ⁴spgorjon@usal.es

¹Viale Europa 28, 08045 Lanusei (Nuoro), Italy

²Viale Marconi 47, 0845 Lanusei (Nuoro), Italy

³Dipartimento di Scienze e Tecnologie Agroambientali
Università degli Studi di Bologna, Via Fanin 42, 40127 Bologna, Italy

⁴Departamento de Botánica y Centro Hispano-Luso de Investigaciones Agrarias
Universidad de Salamanca, Ldo. Méndez Nieto s/n. 37007, Salamanca, Spain

Abstract — A collection of *Fibricium gloeocystidiatum* from Sardinia, Italy, is reported. Previously, this species was only known from Patagonia, Argentina on *Austrocedrus chilensis*. The European specimens were found on the fern *Osmunda regalis* and show some distinguishing characters from the Argentinian specimens. A key to the European species of *Fibricium* is provided.

Keyword — *Steccherinaceae*, wood-inhabiting fungi

Introduction

During the research on distribution and ecology of Aphyllophorales in Mediterranean areas particular care and attention have been devoted to the forests of Sardinia where some new corticioid and polyporoid species have been collected: *Aleurodiscus ilicicola* Bernicchia & Ryvarden, *Phellinus juniperinus* Bernicchia & Curreli, *Neolentiporus squamosellus* Bernicchia & Ryvarden, *Echinodontium ryvardenii* Bernicchia & Piga, *Antrodia sandaliae* Bernicchia & Ryvarden, *Antrodiella ichnusana* Bernicchia et. al. The record of *Piloporia sajanensis* (Parmasto) Niemelä is also worth mentioning. (Bernicchia 1990, 2005, Bernicchia & Piga 1998, Bernicchia & Ryvarden 1988, 1996, 1997, 1998, 2001).

We investigated all kind of substrata, from ferns to cork oak and strawberry tree to hawthorn. Further at the side of a country road (S.S 389 Lanusei- Nuoro),

we became aware of a stand of the beautiful fern *Osmunda regalis* L., which at the base had, partially immersed in the soil, some old and dead leaves covered with small round, whitish patches of corticioid fungi including (among others) *Fibricium gloeocystidiatum*, which we describe below.

Description

Fibricium gloeocystidiatum Rajchenb., Mycotaxon 81: 218, 2002.

Fig. 1

Basidiomata resupinate, effused and easily detachable in very small pieces, hymenial surface smooth and continuous, whitish to cream, very thin, 100-150 μm thick, waxy in the mature parts, farinaceous and pulverulent when young; margin narrow, indeterminate, white, with very thin and numerous rhizomorphs spreading from the margin and invading the substrate; subiculum very thin.

Hyphal system dimitic: generative hyphae thin to slightly thick-walled, with hemispheric clamps at all septa, 1.5-4 μm wide, sometimes slightly wider close to the septa, with a yellowish and refractive content, predominant in subhymenium and subiculum, rare in the rhizomorphs; skeletal hyphae hyaline, thick-walled, unbranched, 1.5-2 μm wide, rare to numerous in the different parts of the basidiomata, abundant in the rhizomorphs and in the invaded wood, very scanty or partially absent in the subiculum. Hyphae gloeopleurous variable in number, sinuous, yellowish, with a dense and refractive content, and giving rise to gloeocystidia. In the material observed crystals are abundant.

Cystidia of two types: 1) gloeocystidia few, sometimes difficult to find, sinuous, rarely fusoid, very often clavate, embedded in the hymenium and with a refractive content, negative in sulfobenzaldehyde, (25) 30-55 (62) $\times$ (4) 5-6.6 (7) μm (mean: 37.1 $\times$ 5.7 μm); 2) cystidia numerous, fusoid to lanceolate, with a blunt apex, wider at the base, thin or slightly thick-walled, with one or two simple septa, basally clamped, (57) 70-85 (105) $\times$ 6.5-8 (10) (mean: 76.6 $\times$ 7.4 μm). All the specimens have some cystidia with clamped septa, but their frequency is very variable and sometimes very scanty. Some intermediate forms between these two types of cystidia have been seen.

Basidia clavate, with four sterigmata and a basal clamp, 17-23 (26) $\times$ 4.5-5.5 (6.5) μm .

Basidiospores hyaline, thin-walled, smooth, IKI-, cyanophile, with a heterogeneous and granular content, often glued together in groups of 2 or 4, variable but with cylindrical shape in general, more rarely ellipsoid, 5-6.5 (7) $\times$ 3 μm (mean: 5.76 $\times$ 3.01; Q= 1.91) (Figure 1).

Remarks: Gloeocystidia are particularly numerous, larger, and with a yellow colour in coll. 8078. In the same specimen, basidiospores are mostly ellipsoid



Figure 1. Microscopic elements of *Fibricium gloeocystidiatum*

and also somewhat larger ($6.5-7 (7.2) \times 3-3.3 \mu\text{m}$), while basidiospores of coll. 8080 are cylindrical and not wider than $2.5 \mu\text{m}$.

Habitat: in Italy collected on *Fraxinus* (?) and at the basal part of the fern *Osmunda regalis*, late in the autumn, growing sometimes with *Trechispora*

laevis K.H. Larss. and *Hypochnicium detriticum* (Bourdot & Galzin) J. Erikss. & Ryvarden.

KNOWN COLLECTIONS: **Argentina** — Chubut, Futaleufú, Los Cipreses, Estancia Pehuén, leg. M. Rajchenberg, coll. 11216; Los Cipreses, Trevelín, Estación Agroforestal INTA, leg. M. Rajchenberg, coll. 11201, 11202, 11208, 11211, on fallen trunks of *Austrocedrus chilensis* (Rajchenberg 2002). **Italy** — Sardinia, Longhifresu, Lanusei (Nuoro) 20.V.2002, on angiosperm wood (*Fraxinus?*), HUBO coll. 4665, leg. A. Arras; S.S. 389 Lanusei-Nuoro country road close to St. Barbara Forest, (Nuoro), 07.XI. 2005, on *Osmunda regalis*, HUBO coll. 5487, 5490, leg. A. Piga and L. Arras; 19.XI.2005, on *Osmunda regalis*, HUBO coll. 5583, 7088, leg. A. Piga and A. Bernicchia; 20.XII.2006 on *Osmunda regalis*, HUBO coll. 8078, leg. L. Arras; 10.II.2007 on *Osmunda regalis*, HUBO coll. 8080, leg. L. Arras.

Discussion

The species may remind one of *Fibricium rude* (P. Karst.) Jülich (Eriksson & Ryvarden 1975), which, however, lacks gloeocystidia and gloeopleurous hyphae. Although M. Rajchenberg confirmed our collections as *F. gloeocystidiatum*, we note the following differences that distinguish the Sardinian specimens from Argentinean collections 11211 and 11216:

- a) Basidiospore shape is more variable and generally cylindrical.
- b) The tissues contain many crystals when inspected microscopically.
- c) Skeletal hyphae appear concentrated in the rhizomorphs but very sparse in the subiculum.
- d) Basidia are larger.
- e) Cystidia with at least some clamped septa occur in all the Italian specimens. (No clamped cystidia were found in the Argentinean specimens.)
- f) Almost all specimens have smaller and difficult to find gloeocystidia that are less visible in phloxine.
- g) Sardinian host substrata include angiosperms and ferns [*Fraxinus* (?) and *Osmunda regalis*] whereas Argentinean substrates are restricted to the gymnosperm, *Austrocedrus chilensis*.

Key to the European species of *Fibricium* J. Erikss.

1. Hymenial cystidia present 2
1. Hymenial cystidia absent *Fibricium subceraceum* (Hallenb.) Bernicchia
2. Without gloeocystidia 3
2. With gloeocystidia and gloeopleurous hyphae .. *Fibricium gloeocystidiatum* Rajchenb.
3. Cystidia not encrusted *Fibricium rude* (P. Karst.) Jülich
3. Cystidia encrusted *Fibricium lapponicum* J. Erikss.

Acknowledgements

Prof. Leif Ryvarden (Norway) and Prof. Nils Hallenberg (Sweden) acted as pre-submission reviewers of the article. The last author is supported by a research grant co-financed by the European Social Fund and the Junta de Castilla y León (Spain). Many thanks to Prof. Mario Rajchenberg (Argentina) who examined our specimens and confirmed the diagnosis.

Literature cited

- Bernicchia A. 1990. *Polyporaceae* s.l. in Italia. Instituto Patologia Vegetale, Università degli Studi di Bologna, 596 pp.
- Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei 10. Ed. Candusso, Italia, 808 pp.
- Bernicchia A, Piga A. 1998. A new species of *Echinodontium* from Italy. Mycotaxon 68: 483-491.
- Bernicchia A, Ryvarden L. 1988. *Aleurodiscus ilexicola* Bern. & Ryv., sp. nov. from Sardinia. Mycol. Helvetica 3(1): 83-88.
- Bernicchia A, Ryvarden L. 1996. Two new brown rot polypores from Italy. Mycol. Helvetica 8(2): 3-10.
- Bernicchia A, Ryvarden L. 1997. *Piloporia sajanensis* (Parmasto) Niemelä, a rare, boreal polypore new to Italy. Mycol. Helvetica 9(1): 85-89.
- Bernicchia A, Ryvarden L. 1998. *Neolentiporus* (Basidiomycetes, Polyporales) in Europe. Cryptogamie, Mycol. 19(4). 281-283.
- Bernicchia A, Ryvarden L. 2001. A new *Antrodia* species (Coriolaceae, Basidiomycetes) from Italy. Mycotaxon 79: 57-66.
- Eriksson J, Ryvarden L. 1975. The *Corticiaceae* of North Europe vol. 3. Fungiflora, Oslo.
- Rajchenberg M. 2002. Corticioid and polyporoid fungi (Basidiomycota) that decay *Austrocedrus chilensis* in Patagonia, Argentina. Mycotaxon 81: 215-227.

MYCOTAXON

Volume 100, pp. 349–356

April–June 2007

Taxonomic revision of the myxomycetes from Cuba deposited in three reference collections: U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK)

M. CAMINO ¹, G. MORENO ² & A. CASTILLO ²

hajib@ceniai.inf.cu, gabriel.moreno@uah.es, aurelio.castillo@uah.es

¹ Jardín Botánico Nacional de Cuba, Universidad de la Habana
Carretera El Rocío, Km 3½, Calabazar, Boyeros
C.P. 19230, Ciudad Habana, Cuba.

² Dpto. de Biología Vegetal (Botánica), Universidad de Alcalá
E-28871 Alcalá de Henares, Madrid, Spain.

Abstract — A revision was made of myxomycetes from Cuba deposited in three reference collections at the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). These specimens were gathered mainly during the 19th century by Charles Wright during expeditions made to this island. All species are discussed and annotated. Identifications are supported by critical point SEM studies of spore ornamentation. Micrographs of spore ornamentation for species little studied by SEM or of particular interest for the island biota are included.

Key words — chorology, *Myxomycota*, taxonomy, Neotropical myxobiota, SEM

Introduction

This paper is a part of a review of historic material of myxomycetes collected in Cuba and deposited in several reference collections. It presents up to date information on this group in Cuba and is a precursor for a revised checklist of Cuban myxomycetes which we are preparing.

A first study (Camino et al. 2005) provided a critical review of specimens deposited in the Farlow Reference Collection (FH-USA). In the present work, we review specimens deposited in the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). *Arcyria cinerea*, *A. denudata*, *Diachea bulbillosa*, *Diderma effusum*, *Hemitrichia calyculata*, *Physarum compressum*, *P. polycephalum*, *Stemonitis splendens* and *Trichia affinis* are cited, and photographs of some specimens are presented.

Materials and methods

The Cuban material studied came from three reference collections: the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). Depending on their conservation state, they were studied macro- and microscopically.

Samples for light microscopy were mounted in Hoyer's medium and PVA according to Schnittler & Novozhilov (1996) and Koske & Tessier (1983). Spore measurements were made with an oil immersion objective and included surface structures such as spines or warts.

Scanning electron microscopy (SEM) images were prepared using the critical point method (Castillo & al. 1997) and micrographs were taken at the University of Alcalá using a Zeiss DSM-950. This technique uses very little material (one sporocarp, a part of it or only a small portion of spores).

In some cases, where the sample was scarce or not well conserved, it was compared with the same collection from the Farlow Collection (FH-USA) and reference was made to Camino et al. (2005).

In the list below, "FCW" indicates *Fungi Cubenses Wrightiani* and "W" indicates Charles Wright. Abbreviations for author citations follow Kirk & Ansell (1992) and those for reference collection citations follow Holmgren & Holmgren (1998).

Taxonomy

Arcyria cinerea (Bull.) Pers., Syn. Meth. Fung.: 184. 1801

≡ *Trichia cinerea* Bull., Herb. France pl. 477, f.3. 1790

= *Arcyria albida* Pers., Neues Mag. Bot. 1: 90. 1794

= *Arcyria bicolor* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc., Bot. 10: 239. 1868

= *Arcyria cinerea* var. *digitata* (Schwein.) G. Lister, Monogr. Mycetozoa, ed. 3: 232. 1925

Specimens examined — CUBA: leg. C. Wright, BM 716 (FCW 542. *Arcyria bicolor*, with an additional label bearing an identification noted by G. Lister as *Arcyria cinerea* var. *digitata*).

Comments — We confirm *Arcyria cinerea* as the correct identification, although the sample comprises only a few sporothecae joined to a single stipe.

Lister (1894) referred to this specimen as *Arcyria albida*. On the label, however, it is identified, possibly later, by G. Lister as *A. cinerea* var. *digitata*. FH maintains a duplicate of this material (Camino & al. 2005).

Arcyria denudata (L.) Wettst., Verh. Zool.-Bot. Ges. Wien 35: Abh. 535. 1886

≡ *Clathrus denudatus* L., Sp. Pl.: 1179. 1753

= *Arcyria punicea* Pers., Neues Mag. Bot. 1: 90. 1794

Specimens examined — CUBA: K 950 as *Arcyria punicea*.

Comments — Study of the specimen confirms that it corresponds to *Arcyria denudata* because of the typical capillitium of this species and the hyaline and almost smooth spores 7-8 µm diam.

This specimen was identified and cited by Lister (1894, 1911) as *Arcyria punicea*.

Diachea bulbilosa (Berk. & Broome) Lister, in Penzig, Myxomyc. Fl. Buitenzorg: 45. 1898

= *Didymium bulbiliosum* Berk. & Broome, J. Linn. Soc. Bot. 14: 84. 1873

Specimens examined — CUBA: K s/n (W- 495 as *Diachea elegans*). K 436 (Cuba, as *Diachea elegans*. Inside the collection box is the stamp of Herbarium Hookerianum 1867).

Comments — In the specimens studied we observed globose sporothecae (squashed as a result of the way in which the material had been conserved) with a white columella and strongly spinose spores 9-10 µm diam.

This specimen (W- 495) is cited also with FCW 537 by Berkeley (1868) as *Diachea elegans*.

Diderma effusum (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 155. 1894

= *Diderma cubense* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10: 347. 1868

Specimens examined — CUBA: BM 518 (FCW 526 as *Diderma cubense* and, on another label, an identification by Lister as *Diderma testaceum*). CUBA: BM 1297 (L: B.M. 55, Cuba, leg. C. Wright).

Comments — The sample BM 518 appeared originally as *Diderma cubense*, although Lister identified it as *Diderma testaceum* (Schrad.) Pers. This material is a duplicate of the specimen cited by Berkeley (1868) as *Diderma cubense* (FH-FCW 526), also studied by us. We conclude that it corresponds with *Diderma effusum* (Camino & al. 2005).

The sample BM 1297 was cited by Lister (1894) with the reference L: B.M. 55 as *Chondrioderma testaceum*.

We agree with Farr (1976) that this is a synonym of *Diderma effusum* and not of *Diderma testaceum*, as indicated by Martin & Alexopoulos (1969).

Hemitrichia calyculata (Speg.) M. L. Farr, Mycologia 66 (5): 887. 1974

= *Hemiarcyria calyculata* Speg., *Anales Soc. Ci. Argent.* 10: 152. 1880

= *Hemitrichia stipitata* (Massee) T. Macbr., N. Amer. Slime-Moulds: 207. 1899

Specimens examined — CUBA: leg. C. Wright, K s/n (W- 259 as *Hemitrichia clavata*. The interior of the collection box reads: 259 *Trichia clavata* Pers.). CUBA: San Juan Mt. Guantánamo, on rotten trunk of a palm tree, July, 1929, leg. B. Hioram, det. V.K. Charles, ex Herbario Collage of Sacred Heart, Guantánamo, BPI 838006 as *H. clavata* and later as *H. stipitata*.

Comments — For this species, we follow the concept of Farr (1974). She studied Spegazzini's type material of *Hemiarcyria calyculata*.

The specimen K s/n was studied by us and corresponds with *Hemitrichia calyculata* in the length of the stipe, form of the calyculus and in having spores 6-7 µm. diam. This specimen was also cited by Berkeley (1868) as *Trichia clavata* (FCW 547, W- 259).

The sample K 1765A cited by Lister (1894) as *Hemitrichia clavata* was not encountered.

Study of the specimen BPI 838006 confirmed that it corresponds with *Hemitrichia calyculata*. Plasmodiocarps of *H. serpula* are present in the same sample.

This species is very frequent in Cuba and was cited recently by Camino (1993, 1998), Pérez & Camino (2000), Camino & Pérez (2001) and Camino & al. (2005).

Physarum compressum Alb. & Schwein., Consp. Fung. Lusat.: 97. 1805

Specimens examined — CUBA: K 1350 (the label also bears additional identifications as *Physarum affine* and W- 907 *Didymium furfuraceum*).

Comments — The same sample was cited by Lister (1894). The material is very sparse and in poor condition; we studied a duplicate of W- 907 deposited in FH which has abundant sporocarps. We confirm the identification by Farr and Lister as *Physarum compressum* (Camino & al. 2005).

Physarum polycephalum Schwein., Schriften Naturf. Ges. Leipzig 1: 63. 1822

= *Didymium obrusseum* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10: 348. 1868

= *Physarum polycephalum* var. *obrusseum* (Berk. & M.A. Curtis) Lister, Monogr. Mycetozoa: 48. 1894

= *Physarum polymorphum* (Mont.) Rostaf., Sluzowce Monogr.: 107. 1874

Specimens examined — CUBA: leg. C. Wright, BM 440 (FCW 532) as *Physarum polycephalum* var. *obrusseum*.

Comments — The sample consists of a slide in poor condition which is a duplicate of FCW-532 deposited of FH (possibly type material of *Didymium obrusseum*) and cited and described by Berkeley (1868) as *Didymium obrusseum*. As examination of this slide was not possible, we studied the original material deposited in FH. As result of this review, and following Alexopoulos (1969), we can confirm that the sample corresponds to *Physarum polycephalum* (Camino & al. 2005).

Lister (1894) cited this specimen (BM 440) as *Physarum polymorphum* and later as *P. polymorphum* var. *obrusseum* (Lister 1911).

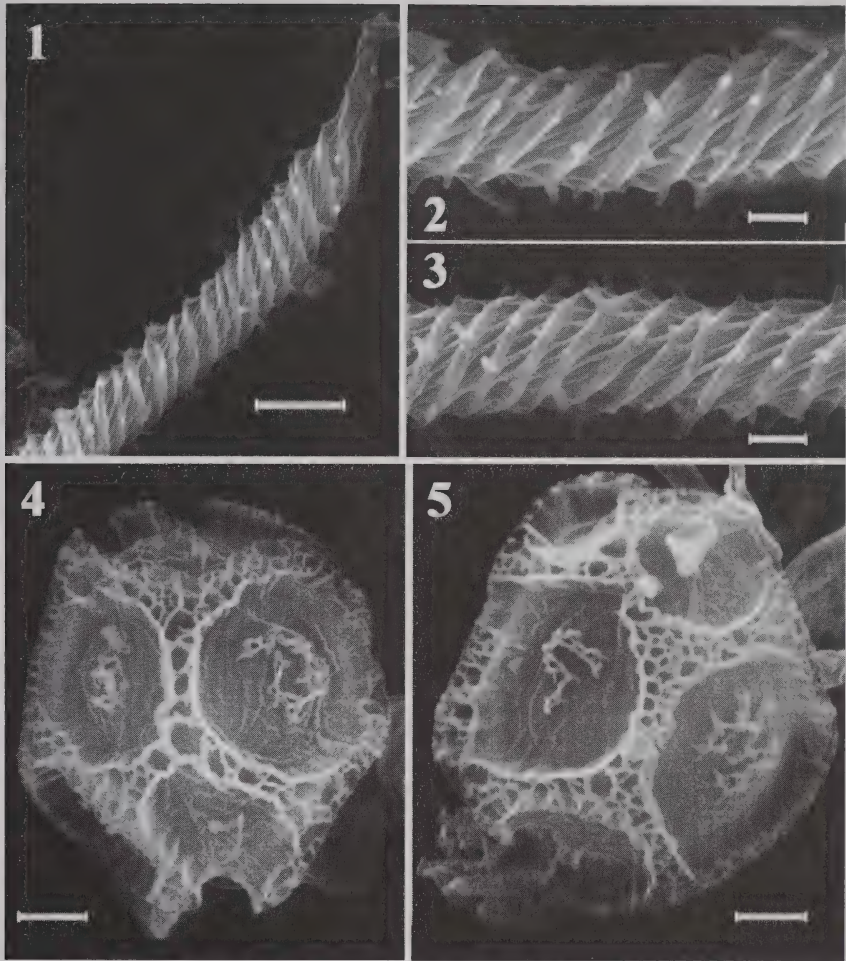
Stemonitis splendens Rostaf., Sluzowce Monogr.: 195. 1874

Specimens examined — CUBA: leg. C. Wright, BM 630 (FCW 538, as *Stemonitis fusca*, with another label bearing an identification by G. Lister as *Stemonitis splendens*). CUBA: K 1603 (W- 261 as *Comatricha longa*, with another label which reads: "*Stemonitis fusca* Roth Cuba, C. Wright").

Comments — Following review of the specimen BM 630, we agree with G. Lister's identification as *Stemonitis splendens* (Lister 1894, 1925).

The specimen K 1603 (W - 261) was cited by Lister (1894, 1911) as *Comatricha longa* (Camino & al. 2005).

The specimens BM 630 and K 1603 correspond with FCW 538 and were cited by Berkeley (1868) as *Stemonitis fusca* (Camino & al. 2005).



Figs. 1-5 *Trichia affinis* BPI 836624. 1. Detail of capillitium (bar = 5 µm). 2-3. Detail of spines in the capillitium (bar = 2 µm). 4-5. Detail of spore ornamentation (bar = 2 µm).

Trichia affinis de Bary,

FIGURES 1-5

in Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 336. 1870

Specimens examined — CUBA: El Yunque, Mt. Baracoa, on *Nephrolepis* sp. in sink hole, March, 1903, leg. L.M. Underwood & F.S. Earle 968, det. Illegible, possibly G.W.M. ex N.Y.B.G., BPI 836624 as *Trichia affinis* but with an alternative identification as *T. persimilis*. CUBA: La Prenda, January, 1923, leg. Br. Hioram 5436, det. W.W. Diehl, BPI 836152 as *T. affinis*.

Comments — Some authors, such as Farr (1958) and Martin & Alexopoulos (1969) treat this species together with *Trichia affinis* as synonyms of *T. favoginea*,

but we prefer to consider them as independent taxa following Nannenga-Bremekamp (1991). *Trichia favoginea* differs from *T. affinis* and *T. persimilis* in capillitium thickness (8–10 µm diam.), whereas *T. affinis* and *T. persimilis* have thinner capillitium tubes (4–6 µm diam.). It is difficult to separate the last two species; spore ornamentation is the principal character to differentiate them. *Trichia affinis* has reticulate spores with peaks in the ornamentation up to 1 µm high and discontinuous, whereas *T. persimilis* presents a broken reticulation of small meshes, with very incomplete peaks and with smooth areas without reticulation. The presence of small spines in the capillitium is a variable character and is sometimes present in both species.

The most recent identification of the sample BPI 836624 appears to be *Trichia affinis* because this name appears on the original label in another colour. The first identification was as *T. persimilis*.

The specimen BPI 836152 has capillitium tubes with spiny spiral bands up to 6 µm wide; spores with a well-developed reticulum, 10–12 µm. The specimen BPI 836624 has capillitium tubes with very small spines and spores of 11–13 µm with a complete and well-developed reticulum. Both correspond with *Trichia affinis*.

Doubtful material

- **BM 92**, CUBA: FCW 537 as *Diachea elegans* (Trentep.) Fr., another note “*Diachea leucopodia* Rost.”

Comments — We saw only one slide in very bad condition. Identification was impossible and the original identification has therefore been followed here.

Although *Diachea elegans* is a synonym of *D. leucopodia* (Lado 2001) it would be incorrect to identify the specimen BM 92 (FCW 537) as *D. leucopodia* because Berkeley (1868) cited four specimens with FCW 537 as the reference number, and some correspond to *Diachea bulbilosa* while others correspond to *D. leucopodia* (Camino & al. 2005). Clearly BM 92 is a duplicate of one of the items cited by Berkeley (1868).

- **K 1501**, CUBA: leg. C. Wright, W- 483, on old bark, as *Didymium farinaceum* Fr.
- **K 1500**, CUBA: leg. C. Wright, W- 455 as *Didymium farinaceum* Fr.

Comments — It was impossible to study the specimens K 1500 and 1501 because only remnants of stipes remain.

We examined the specimens W- 483 and 455 deposited in FH (cited by Berkeley 1868, as *Didymium farinaceum*), but both samples were in a condition making any study impossible (Camino & al. 2005).

- **BPI 821255**, CUBA: La Prenda, Jan. 1923, leg. Br. Hioram 6759, det. W. W. Diehl, as *Comatricha elegans*, the collection box lid bears the handwritten note “only *Physarum* seen”.

Comments — The material was in a bad condition. It was possible only to confirm that it corresponds to *Physarum*, as indicated in the box. Identification to species level was not possible.

Acknowledgements

This investigation was partly financed by research project REN2002-01965 of the Ministerio de Asuntos Exteriores and Ministerio de Ciencia y Tecnología, Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica. Another part was financed by a Miguel de Cervantes Scholarship of the University Alcalá de Henares for the first author, and her visit to the BM and K reference collections was supported by the UK Darwin Initiative Project Biodiversity Conservation in Cuba. We express our gratitude to Dr Javier Rejos, curator of the AH reference collection, and the curators and staff of BPI, BH and K collections. Also to J.A. Pérez and A. Priego, Service of Electronic Microscopy, University of Alcalá de Henares, for their invaluable help with the SEM, and wish to thank Dr D.W. Minter and Mr D.W. Mitchell for the revision of the manuscript.

References

- Alexopoulos CJ. 1969. The experimental approach to the taxonomy of the myxomycetes. *Mycologia* 61(2): 219-239.
- Berkeley MJ. 1868. On a collection of fungi from Cuba. Part II. *J. Linn. Soc. Bot.* 10: 341-392.
- Camino M. 1993 ["1991"]. *Myxomycetes de Cuba. I. Revista Jard. Bot. Nac. Univ. Habana* 12: 127-131.
- Camino M. 1998. Los Myxomycetes del Hoyo de Bonet, Sierra de Cubitas, Camagüey. *Revista Jard. Bot. Nac. Univ. Habana* 19: 161-162.
- Camino M, Pérez JM. 2001. Los Myxomycetes de la Reserva Ecológica "Alturas de Banao" (El Naranjal), Sancti Spíritus. *Revista Jard. Bot. Nac. Univ. Habana* 22: 109-117.
- Camino M, Moreno G, Castillo A. 2005. Taxonomic revision of the myxomycetes from Cuba deposited in the Farlow Herbarium (USA). *Mycotaxon* 93: 379-400.
- Castillo A, Moreno G, Illana C, Lago J. 1997. A critical study of some *Stemonitales*. *Micol. Res.* 101: 1329-1340.
- Farr ML. 1958. Taxonomic studies in the myxomycetes I. The *Trichia favoginea* complex. *Mycologia* 50: 357-369.
- Farr ML. 1974. Earlier names for *Hemitrichia stipitata* (Myxomycetes). *Mycologia* 66: 887-888.
- Farr ML. 1976. Flora Neotropica Monograph No. 16. *Myxomycetes*. New York Botanical Garden. 304 pp.
- Holmgren, PK, Holmgren NH. 1998ff. (continuously updated). Index Herbariorum. New York Botanical Garden. New York. <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>
- Kirk PM, Sell AE. 1992. Author of fungal names. A list of authors of scientific names of fungi, with recommended standard forms of their names, including abbreviations. Index of fungi supplement. CAB International, 95 pp.
- Koske RE, Tessier B. 1983. A convenient permanent slide mounting medium. *Micol. Soc. Amer. Newsletter* 34: 59.
- Lado C. 2001. Nomenmyx, a nomenclatural taxabase of Myxomycetes. *Cuadernos de trabajo de Flora Micológica Ibérica* 16: 1-221.

- Lister A. 1894. A Monograph of the *Mycetozoa*, being a descriptive catalogue of the species in the Herbarium of the British Museum. British Museum (Nat. Hist.) Cromwell road, London 224 pp, 78 pls.
- Lister A. 1911. A Monograph of the *Mycetozoa* (ed. 2. rev. G. Lister). British Museum (Nat. Hist.). London. 302 pp, 200 pls.
- Lister A. 1925. A Monograph of the *Mycetozoa* (ed. 3. rev. G. Lister). British Museum (Nat. Hist.). London. 296 pp, 200 pls.
- Martin GW, Alexopoulos CJ. 1969. The *Myxomycetes*. Univ. Iowa Press. Iowa. 561 pp.
- Nannenga-Bremekamp NE. 1991. A guide to temperate *Myxomycetes*. Biopress Limited. Bristol. 409 pp.
- Pérez JM, Camino M. 2000. Riqueza micológica en un sitio natural del Jardín Botánico Nacional. Revista Jard. Bot. Nac. Univ. Habana 21: 133-137.
- Schnittler M, Novozhilov Y. 1996. The myxomycetes of boreal woodlands in Russian northern Karelia: a preliminary report. Karstenia 36: 19-40

NOMENCLATURAL NOVELTIES PROPOSED IN MYCOTAXON 100

- Agaricus campbellensis* Geml, Laursen & D. Lee Taylor, p. 202
- Agaricus subantarcticus* Geml, Laursen & D. Lee Taylor, p. 204
- Alternaria calycipyricola* R.G. Roberts, p. 162
- Alternaria ventricosa* R.G. Roberts, p. 164
- Amaurodon sumatranus* Miettinen & Kõljalg, p. 52
- Anomoloma* Niemelä & K.H. Larss., p. 312
- Anomoloma albolutescens* (Romell) Niemelä & K.H. Larss., p. 312
- Anomoloma flavissimum* (Niemelä) Niemelä, K.H. Larss. & Y.C. Dai, p. 313
- Anomoloma myceliosum* (Peck) Niemelä & K.H. Larss., p. 313
- Anomoloma rhizosum* Y.C. Dai & Niemelä, p. 313
- Batkoa cercopidis* (S. Keller) B. Huang, Humber & K.T. Hodge, p. 231
- Batkoa pseudapiculata* (S. Keller) B. Huang, Humber & K.T. Hodge, p. 231
- Cacumisporium pleuroconidiophorum* (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr., p. 332
- Clitopilus amygdaliformis* Zhu L. Yang, p. 242
- Colletotrichum yunnanense* Xiao Ying Liu & W.P. Wu, p. 139
- Conidiobolus margaritatus* B. Huang, Humber & K. T. Hodge, p. 230
- Corynespora merrillioanacis* Zh.Q. Shang & X.G. Zhang, p. 155
- Corynespora micheliae* Zh.Q. Shang & X.G. Zhang, p. 157
- Cyathicula* sect. *Scelobelonium* (Sacc.) M. Chleb. & Chleb., p. 44
- Cyathicula brunneospora* M. Chleb. & Chleb., p. 38
- Cyathicula melanospora* (Rehm.) M. Chleb. & Chleb., p. 42
- Dichomitus hexagonoides* (Speg.) Robledo & Rajchenb., p. 7
- Endococcus variabilis* Halici, Kocourk. & Diederich, p. 338
- Entorrhiza casparyana* (Magnus) Lagerh. var. *tenuis* Denchev & H.D. Shin, p. 74
- Guignardia fici* Sawada, W.Y. Li & W.Y. Zhuang, p. 213
- Guignardia fici-septicae* Sawada, W.Y. Li & W.Y. Zhuang, p. 214
- Guignardia linderae* Sawada, W.Y. Li & W.Y. Zhuang, p. 216
- Guignardia manihoticola* Sawada, W.Y. Li & W.Y. Zhuang, p. 216
- Guignardia polygoni-chinensis* Sawada, W.Y. Li & W.Y. Zhuang, p. 218
- Guignardia smilacicola* Sawada, W.Y. Li & W.Y. Zhuang, p. 219
- Helicoma indicum* Gawas & Bhat, p. 298
- Hygrophorus robustus* F.Q. Yu, p. 170
- Leucoagaricus dextrinoidesporus* (Z. S. Bi) Zhu L. Yang, p. 280
- Leucoagaricus sinicus* (J. Z. Ying) Zhu L. Yang, p. 283
- Mayamontana* Castellano, Trappe & Lodge, p. 291

- Mayamontana coccolobae* Castellano, Trappe & Lodge, p. 291
Phaeodothis hainanensis (Teng) You Z. Wang, p. 98
Phaeomonilia R.F. Castañeda, Heredia & R.M. Arias, p. 328
Phaeomonilia corticola (R.F. Castañeda) R.F. Castañeda, Saikawa & M. Stadler,
p. 332
Phaeomonilia pleiomorpha R.F. Castañeda, Heredia & R.M. Arias, p. 329
Phaeoramularia delphinii F.Y. Zhai, Y.L. Guo & Yu Li, p. 189
Phyllachora tengchongensis Na Liu & L. Guo, p. 251
Pirottaea atrofusca Chleb. & M. Chleb., p. 45
Plasmopara constantinescui Voglmayr & Thines, p. 18
Pseudospiropes ximeniae Zh.Q. Shang & X.G. Zhang, p. 150
Pseudospiropes mussaendae Zh.Q. Shang & X.G. Zhang, p. 151
Vittalia Gawas & Bhat, p. 295
Vittalia indica Gawas & Bhat, p. 296

AUTHOR INDEX—VOLUME 100

- Águeda, B., see Fernández-Toirán & Águeda
- Aksoy, Ahmet, see Halıcı & al.
- Alstrup, Vagn, see Sohrabi & Alstrup
- Aptroot, André, see Yazıcı & Aptroot
- Arias, Rosa Maria, see Castañeda Ruiz & al.
- Arras, Luigi, Andrea Piga, Annarosa Bernicchia & Sergio Pérez Gorjón. *Fibricium gloeocystidiatum* (Polyporales, Basidiomycetes), new to Europe. 100: 343–347. 2007.
- Bernicchia, Annarosa, see Arras & al.
- Bernicchia, Annarosa, Elena Savino & Sergio Pérez Gorjón. Aphyllophoraceous wood-inhabiting fungi on *Abies alba* in Italy. 100: 185–188. 2007.
- Bhat, D.J., see Gawas & Bhat
- Blanco, María Natividad, G. Moreno & J. Checa. Two rare corticioid species with globose spores. 100: 269–277. 2007.
- Calvalcanti, Maria A.Q., see Wartchow & al.
- Camino, M., G. Moreno & A. Castillo. Taxonomic revision of the myxomycetes from Cuba deposited in three reference collections: National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). 100: 349–356. 2007.
- Candan, Mehmet, see Halıcı & al.
- Castañeda Ruiz, Rafael F., Gabriela Heredia Abarca, Rosa Maria Arias, Masatoshi Saikawa, David W. Minter & Marc Stadler. Anamorphic fungi from submerged plant material: *Phaeomonilia pleiomorpha*, *P. corticola* and *Cacumisporium pleuroconidiophorum*. 100: 327–336. 2007.
- Castellano, Michael A., James M. Trappe & D. Jean Lodge. *Mayamontana coccolobae* (Basidiomycota), a new sequestrate taxon from Belize. 100: 289–294. 2007.
- Castillo, A., see Camino & al.
- Chamswarng, Chiradej, see Jeamjitt & al.
- Checa, J., see Blanco & al.
- Chlebická, Markéta & Andrzej Chlebicki. *Cyathicula brunneospora* and *Pirottaea atrofusca*, two new *Helotiales* from Tian Shan (Kazakhstan). 100: 37–50. 2007.
- Chlebicki, Andrzej, see Chlebická & Chlebicki
- Choi, Young-Joon, see Denchev & al.
- Cléménçon, H., K. Hosaka & A.F.S. Taylor. Rhizomorph anatomy confirms the taxonomic position of *Sclerogaster* (Phallomycetidae, Basidiomycota). 100: 85–95. 2007.
- Coelho, Gilberto, Vagner G. Cortez & Rosa T. Guerrero. New morphological data on *Amauroderma brasiliense* (Polyporales, Basidiomycota). 100: 177–183. 2007.
- Cortez, Vagner G., see Coelho & al.
- Dai, Yu-Cheng, see Niemelä & al.
- Denchev, Cvetomir M., Hyeon-Dong Shin & Sung Min Kim. New records of smut fungi from Korea. 2. 100: 73–78. 2007.

- Denchev, Cvetomir M., Young-Joon Choi, Seung-Kyu Lee & Hyeon-Dong Shin.
New records of smut fungi from Korea. 1. 100: 67–72. 2007.
- Denchev, Cvetomir M., see Sultan & al.
- Diederich, Paul, see Halıcı & al.
- Duan, Junxing, see Liu & al.
- Fernández-Toirán, L.M. & B. Águeda. Fruitbodies of *Cenococcum geophilum*.
100: 109–114. 2007.
- Gams, W., see Schroers & al.
- Gawas, Puja & D.J. Bhat. *Vittalia indica* gen. & sp. nov. and *Helicoma indicum* sp. nov.
from the forests of northeastern India. 100: 295–303. 2007.
- Geml, József, Gary A. Laursen, Harris C. Nusbaum & D. Lee Taylor. Two new species
of *Agaricus* from the Subantarctic. 100: 193–208. 2007.
- Gómez-Bolea, A., see Olariaga & al.
- Guerrero, Rosa T., see Coelho & al.
- Guo, Lin, see Liu & Guo
- Guo, Ying-Lan, see Zhai & al.
- Guzmán-Dávalos, Laura, see Torres-Torres & al.
- Halıcı, Mehmet Gökhan, Mehmet Candan & Aysen Özdemir Türk. New records
of lichenicolous and lichenized fungi from Turkey. 100: 255–260. 2007.
- Halıcı, Mehmet Gökhan, Jana Kocourková, Paul Diederich & Ahmet Aksoy.
Endococcus variabilis, a new species on *Staurothele areolata*. 100: 337–342. 2007.
- Haq, Ikram-ul, see Sultan & al.
- He, Wen-Hua, see Wang & He
- Heredia Abarca, Gabriela, see Castañeda Ruiz & al.
- Hestmark, Geir. Typification of *Umbilicaria cinereorufescens*. 100: 235–240. 2007.
- Hodge, Kathie T., see Huang & al.
- Hosaka, K., see Cléménçon & al.
- Hoyo, M.P., see Olariaga & al.
- Huang, Bo, Richard A. Humber & Kathie T. Hodge. A new species of *Conidiobolus*
from Great Smoky Mountains National Park. 100: 227–233. 2007.
- Humber, Richard A., see Huang & al.
- Jeamjitt, Onuma, Leka Manoch, Niphon Visarathanonth, Chiradej Chamswarnng,
Roy Watling, George P. Sharples & Anake Kijjoa: Coprophilous ascomycetes of
Thailand. 100: 115–136. 2007.
- Khalid, A.N., see Sultan & al.
- Kijjoa, Anake, see Jeamjitt & al.
- Kim, Sung Min, see Denchev & al.
- Köljal, Urmas, see Miettinen & Köljal
- Korf, Richard P. A tribute to Grégoire Laurent Hennebert and Mycotaxon's 100th
volume. 100: 1–4. 2007.
- Kocourková Jana., see Halıcı & al.
- Larsson, Ellen, see Niemelä & al.
- Larsson, Karl-Henrik, see Niemelä & al.

- Laursen, Gary A., see Geml & al.
- Lee, Seung-Kyu, see Denchev & al.
- Li, Wen-Ying & Wen-Ying Zhuang. Re-examinations of *Botryosphaeriaceae* (*Dothideomycetes*) from China on deposit in HMAS. 100: 209–220. 2007.
- Li, Yu, see Zhai & al.
- Liu, Na & Lin Guo. *Phyllachora tengchongensis* sp. nov. and a new record of *Phyllachora* (*Phyllachorales*) from China. 100: 251–254. 2007.
- Liu, Pei-Gui, see Yu & al.
- Liu, Xiaoying, Xiangming Xie & Junxing Duan. *Colletotrichum yunnanense* sp. nov., a new endophytic species from *Buxus* sp. 100: 137–144. 2007.
- Lodge, D. Jean, see Castellano & al.
- Manoch, Leka, see Jeamjitt & al.
- Medel, Rosario. First record of the genus *Byssosphaeria* (*Pleosporales*) in Mexico and Venezuela. 100: 247–250. 2007.
- Miettinen, Otto & Urmas Kõljalg. *Amaurodon sumatranus* (*Thelephorales*, *Basidiomycota*), a new species from Indonesia. 100: 51–59. 2007.
- Minter, David W., see Castañeda Ruiz & al.
- Moreno, G., see Blanco & al.
- Moreno, G., see Camino & al.
- Niemelä, Tuomo, Karl-Henrik Larsson, Yu-Cheng Dai & Ellen Larsson. *Anomoloma*, a new genus separated from *Anomoporia* on the basis of decay type and nuclear rDNA sequence data. 100: 305–317. 2007.
- Nusbaum, Harris C., see Geml & al.
- Olariaga, I., M.P. Hoyo, A. Gómez-Bolea & I. Salcedo. Typification and description of *Typhula buxi*. 100: 27–35. 2007.
- Pérez Gorjón, Sergio, see Arras & al.
- Pérez-Gorjón, Sergio, see Bernicchia & al.
- Piga, Andrea, see Arras & al.
- Putzke, Jair, see Wartchow & al.
- Rajchenberg, Mario, see Robledo & Rajchenberg
- Roberts, Rodney G. Two new *Alternaria* species from pear fruit. 100: 159–167. 2007.
- Robledo, Gerardo L. & Mario Rajchenberg. South American polypores: first annotated checklist from Argentinean Yungas. 100: 5–9. 2007.
- Ryvarden, Leif, see Torres-Torres & al.
- Saikawa, Masatoshi, see Castañeda Ruiz & al.
- Salcedo, I., see Olariaga & al.
- Samuels, G.J., see Schroers & al.
- Savino, Elena, see Bernicchia & al.
- Schroers, H.-J., G.J. Samuels & W. Gams. Did Mussat make new combinations in *Sylloge Fungorum* XV, 1901? 100: 221–225. 2007.
- Shang, Zhi-Qiang & Xiu-Guo Zhang. Taxonomic studies of *Pseudospiropes* from Yunnan, China. 100: 149–153. 2007.
- Shang, Zhi-Qiang & Xiu-Guo Zhang. Two new *Corynespora* species from Jiangsu, China. 100: 155–158. 2007.

- Sharples, George P., see Jeamjitt & al.
- Shin, Hyeon-Dong, see Denchev & al.
- Sohrabi, Mohammad & Vagn Alstrup. Additions to the lichen mycota of Iran from East Azerbaijan Province. 100: 145–148. 2007.
- Spribille, Toby & Tor Tønsberg. *Mycoblastus marginatus*, a new synonym for *M. affinis* (Mycoblastaceae, lichenized Ascomycota). 100: 105–107. 2007.
- Stadler, Marc, see Castañeda Ruiz & al.
- Sultan, Muhammad Asim, Cvetomir M. Denchev, Ikram-ul-Haq & A.N. Khalid. A new record of *Bauhinus piperi* (Microbotryales) from Pakistan. 100: 79–83. 2007.
- Sun, Guangyu, Junlin Zhang & Rong Zhang. Four new Chinese records of *Petriella* and *Pseudallescheria* (Microascales). 100: 61–65. 2007.
- Taylor, A.F.S., see Cléménçon & al.
- Taylor, D. Lee, see Geml & al.
- Thines, Marco, see Voglmayr & Thines
- Tønsberg, Tor, see Spribille & Tønsberg
- Torres-Torres, Mabel Gisela, Laura Guzmán-Dávalos & Leif Ryvarden. New data and localities for *Navisporus* in America. 100: 319–326. 2007.
- Trappe, James M., see Castellano & al.
- Türk, Ayşen Özdemir, see Halıcı & al.
- Visarathanonth, Nippon, see Jeamjitt & al.
- Voglmayr, Hermann & Marco Thines. Phylogenetic relationships and nomenclature of *Bremiella sphaerosperma* (Chromista, Peronosporales). 100: 11–20. 2007.
- Wang, You-Zhi & Wen-Hua He. Notes on *Amphisphaeria*-like species in HMAS, with a new combination: *Phaeodothis hainanensis* (Pleosporales). 100: 97–104. 2007.
- Wartchow, Felipe, Jair Putzke & Maria A. Q. Cavalcanti. *Ripartitella* (Agaricales) from an Atlantic Forest in Pernambuco, Brazil. 100: 260–267. 2007.
- Watling, Roy, see Jeamjitt & al.
- Xie, Xiangming, see Liu & al.
- Xu, Guang-Bo, see Yu & al.
- Yang, Zhu L. *Clitopilus amygdaliformis*, a new species from tropical China. 100: 241–246. 2007.
- Yang, Zhu L. Type studies on *Chamaeota* species described from China. 100: 279–287. 2007.
- Yazıcı, Kenan & André Aptroot. Five lichens new to Turkey. 100: 21–26. 2007.
- Yu, Fu-Qiang, Guang-Bo Xu & Pei-Gui Liu. A new and noteworthy species of *Hygrophorus* from Yunnan, China. 100: 169–175. 2007.
- Zhai, Feng-Yan, Ying-Lan Guo & Yu Li. A new species of *Phaeoramularia* on *Ranunculaceae*. 100: 189–192. 2007.
- Zhang, Junlin, see Sun & al.
- Zhang, Rong, see Sun & al.
- Zhang, Xiu-Guo, see Shang & Zhang
- Zhuang, Wen-Ying, see Li & Zhuang

REVIEWERS, VOLUME ONE HUNDRED

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

Reinhard Agerer	Laura Guzmán-Davalos	Lorelei L. Norvell
Teuvo Ahti	Gastón Guzmán	Shoji Ohga
Joseph F. Ammirati	Nils Hallenberg	Nichole R. O'Neill
Birgitte Andersen	Roy E. Halling	Silvano Onofri
André Aptroot	David L. Hawksworth	Alan Orange
Hans Otto Baral	David S. Hibbett	Clark L. Ovrebo
Timothy J. Baroni	Kevin D. Hyde	Shaun R. Pennycook
Margarita A. Bondartseva	Per Magnus Jørgensen	Ronald H. Petersen
Arthur A. Callaghan	W. Bryce Kendrick	Christian Printzen
Francisco D. Calonge	Paul M. Kirk	Jack D. Rogers
Sharon A. Cantrell	Urmaz Köljal	Amy Y. Rossman
Julieta Carranza	Richard P. Korf	Leif Ryvarden
Lori M. Carris	Bradley R. Kropp	Roger G. Shivas
Paul Diederich	Shidong Li	Emory Simmons
Ove Eriksson	Taihui Li	Otmar Spring
Fernando A. Fernandez	Clarice Loguercio-Leite	Joost Stalpers
Alan Fryday	P. Manimohan	Steven Stephenson
Ricardo Márquez Galán	Eric H.C. McKenzie	Leif Tibell
Walter Gams	Thomas May	Kálmán Vánky
Paolo Giordani	Ireneia Melo	Else V. Vellinga
Roger D. Goos	David W. Mitchell	Orvo Vitikainen
Cheryl Grgurinovic	Royall T. Moore	Tian-Yu Zhang
Adriana de Mello Gugliotta	Gabriel Moreno	Zhongyi Zhang
Luís F.P. Gusmão	Gregory M. Mueller	Wen-ying Zhuang

ERRATA

VOLUME 69

Inside front cover, line 19	for: <i>Trichosporium</i>	read: <i>Trichosporium</i>
p.iv, line 15	for: <i>Trichosporium</i>	read: <i>Trichosporium</i>
p.524, line 38	for: <i>Trichosporium</i>	read: <i>Trichosporium</i>

VOLUME 99

Cover 1, line 14	for: period wood decay	read: poroid wood decay
Cover 3, line 11	for: Victor	read: Victor M.
p. iii, line 12	for: period wood decay	read: poroid wood decay
p. iv, bottom line	for: Victor	read: Victor M.
p.251, line 11	for: Pest	read: Pests
p.253, line 3	for: Keshavarzi	read: Agriculture
p.254, lines 2,7,9,12,16,21,24	for: Saber et al. 2000	read: Saber & Minassian 2000
p.254, line 22	for: Saber et al. 2002	read: Saber 2002
p.258, line 17	for: Saber et al. 2000	read: Saber & Minassian 2000
p.265, line 6	for: species especially	read: especially
p.265, line 12	for: <i>adpersum</i> ,	read: <i>adpersum</i>)
p.268, line 32	ADD: Saber M. 2002. New records of wood-inhabiting fungi (<i>Basidiomycetes</i>) from Iran. 15 th Iranian Plant Protection Congress, Kermanshah, Iran.	
p.375, 3 rd from bottom	for: period wood decay	read: poroid wood decay
p.375, line 9	for: Victor	read: Victor M.
p.376, 1 from bottom	for: Victor	read: Victor M.

FROM THE *EDITOR-IN-CHIEF*

MYCOTAXON 100

It is with great pleasure that the Editors and Editorial Board of MYCOTAXON dedicate our century volume to one of its founding co-Editors, Grégoire L. Hennebert. To make this volume special, we include an opening dedication written by our other founder (100: 1–4). Richard P. Korf reminisces over what motivated Grégoire and him to design a mycological journal to expedite the publication of taxonomic papers and briefly traces the history of MYCOTAXON from its first 64-page issue, Volume 1(1), published on September 16, 1974 through the current 370-page volume scheduled for a May 2007 release. I have been pleased to direct its transition from a journal prepared exclusively from author-produced hard copy to one now completely digitally prepared. Proud that the current volume contains 48 new names proposed in 45 papers co-written by 121 authors representing 32 different countries, I wonder with Prof. Korf what other changes may be in store for this truly international journal on fungal taxonomy and nomenclature.

MYCOTAXON 100 also introduces another visual change. Its front cover bears an illustration taken from Grégoire's thoughtful 1991 paper on the problems with the nomenclature of pleoanamorphic fungi as governed by the frequently controversial Article 59 in the International Code of Botanical Nomenclature. Future volumes will continue to display line drawings on front covers, but each illustration will be chosen from among original figures by authors of papers included within each current volume. MYCOTAXON subscription information has been moved to the inside front cover to make room for the Table of Contents that will now begin on the back cover. We hope you are as pleased with these changes as we are.

We are also happy to report that MYCOTAXON has — finally — returned to its prompt publication schedule. This Friday afternoon, all editorial correspondence is current and only three manuscripts await final editorial review, all of which will certainly appear in the July–September volume, MYCOTAXON 101. Baring unforeseen circumstances, we now anticipate that manuscript turn-around time should rarely exceed 90-days from receipt of the final submission in the Editor-in-Chief's office to publication date, with most manuscript turn-arounds averaging considerably less!

Shaun Pennycook (*Nomenclature Editor*), Cony Decock (*French Language Review Editor*), David Hawksworth (*Book Review Editor*), Karen Gettelman (*Index Editor*), Noni Korf (*Webmaster*), and the *Editorial Advisory Board* (Wen-Ying Zhuang, Don Pfister, Carol Shearer, Shaun Pennycook, Seppo Huhtinen, and Gary Samuels) join Dick and me in wishing Grégoire well and in looking forward to MYCOTAXON's next 100 volumes.

Lorelei L. Norvell,
Editor-in-Chief

11 May 2007

THE '4-STEP' MYCOTAXON SUBMISSION PROCESS

MYCOTAXON's instructions PDF (updated in 2006), which can be downloaded from the INSTRUCTIONS TO AUTHORS webpage on www.mycotaxon.com, provides more information than the abbreviated version last published in MYCOTAXON (94: 401–411). As we continue to simplify submission protocols, we urge prospective authors to download other guides by clicking the 'file download page' link on the instructions page and to read the Editor's blog [www.mycotaxon.com/about/weblog.html] for last minute changes before submitting to the journal.

Step 1—PEER REVIEW: Authors send a formatted text document with illustration files and MYCOTAXON Reviewer checklist to two experts for peer review. Authors should (i) make certain that both peer reviewers have Emailed the checklist forms to the *Editor-in-Chief* and (ii) revise their manuscript according to reviewer suggestions **before** submitting a master text file to the *Nomenclature Editor* for nomenclatural review.

Step 2—NOMENCLATORIAL & FRENCH LANGUAGE REVIEW: Authors next Email their revised master text file (containing footnotes, tables and captions but **NO** illustrations) to the *Nomenclature Editor* <PennycookS@LandcareResearch.co.nz> for accession and pre-submission review. The Email message **MUST** include the word 'MYCOTAXON' on the subject line and **MUST** include names **and** Email addresses of all peer reviewers. (Manuscripts written in French should also be submitted to the *French Language Editor* <decock@mbia.ucl.ac.be> at this time.) Editors will return annotated files with a list of needed corrections to the authors and *Editor-in-Chief*.

Step 3—FINAL SUBMISSION: After authors receive their manuscript accession number and make revisions requested during nomenclatural review, they should send (i) a completed MYCOTAXON submission form; (ii) separate text files for main text, tables, and legends; and (iii) art files to the *Editor-in-Chief* <editor@mycotaxon.com>. **Only** text and image files considered ready for immediate publication should be sent at this time. The *Editor-in-Chief* will try to acknowledge receipt of files within two weeks. Authors are asked to wait at least 14 days before sending a follow-up query, to avoid unnecessary Email traffic near press deadlines or during temporary closures of the editorial office.

Step 4—PRESS PREPARATION: After preparing a press-quality PDF from the author's text and art files, the *Editor-in-Chief* sends journal entries for the nomenclatural novelties and author index pages with the PDF proof to all coauthors for approval. Editorial errors are always corrected free of charge, but authors who ask the *Editor-in-Chief* to correct errors present in their original files will be charged \$10 per correction (minimum charge of \$40). Payment arrangements of all fees should be made by writing the *Treasurer* <info@mycotaxon.com>.

MYCOTAXON frequently updates its webpages and regularly posts abstracts, table of contents, indices, annotated distributional species lists, and revised instructions and forms on its website. We invite all of you to browse our website frequently for updated journal and other interesting mycological news.

WWW.MYCOTAXON.COM

RECENT BOOKS FROM MYCOTAXON

Prices include surface mail shipment (*for more books see www.mycotaxon.com/books.html*)

Mycotaxon, Ltd., P. O. Box 264, Ithaca, NY 14851-0264, U.S.A.

John Brown's Body, by Stephen Vincent Benét

Audio book narrated by Dick Korf

Mycotaxon, Ltd. 2006. Limited edition of 100 copies.

12 CD discs in plastic box 5.75 x 5.25 x 1 inches, plus 8-page liner notes.

Not for sale. No ISBN. enquiries: <info@mycotaxon.com>.

Central European Lichens - Diversity and Threat

Edited by Anna Lackovicova, Anna Guttova, Eva Lisicka and Pavel Lizon

Mycotaxon, Ltd. 2006. Hardbound and Softbound editions, 364 pp., illustrated, 17 x 24 cm.

For exchange only, contact Eva Zaletova, Institute of Botany, Slovak Academy of Sciences, Dubravská cesta 14, 845 23 Bratislava, Slovakia, <eva.zaletova@savba.sk>. ISBN 0-930845-14-5 (hardbound ed.), 0-930845-15-3 (softbound ed.)

Fungi of China, by S. C. Teng

Mycotaxon, Ltd. 1996. Hardbound, xiv + 586 pp., 426 illustrations, map, portrait, index, 8-1/2x11 inches. \$79.00.

Airmail price varies by country: enquire. ISBN 0-930845-05-6.

Edited by Richard P. Korf, with a foreword by Teng's daughter, Rosaline Z. Deng.

Proceeds from sales go to the Teng family.

Special for Mycotaxon subscribers: deduct \$20 from regular price!

What reviewers say about Teng's Fungi of China:

"... one of the most valuable books on the fungi of China ever published in English." —*Mycologia* 90: 1091-1092, 1998.

"... a great big blue uncompromising brick of a book ... an instant classic. Anyone interested in identification of fungi, particularly in Asia, should get this book immediately. Mycology owes another debt to Dick Korf for his sympathetic and intelligent editing of this superb work." —*Bibliography of Systematic Mycology* 10(6): xlviii-xlix, 1998.

"The book is important for any researcher interested in the systematic relationships, diversity, and distribution of fungi on a global scale." - *New Zealand Journal of Botany* 35: 265-266, 1977.

Fungi of Northwestern China, edited by Wen-Ying Zhuang

Mycotaxon, Ltd. 2005. Hardbound, 430 pp., 26 x 18.5 cm. US\$40.00 plus postage. ISBN 0-930845-14-5.

(Please order direct from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 3887 named species belonging to 759 genera of fungi (slime molds, plasmodiophoromycetes, chytrid, oomycetes, zygomycetes, lichens, non-lichenized ascomycetes, anamorphic fungi, rusts, smuts, and the basidiomycetous macrofungi) hitherto known from Gansu, Ningxia, Qinghai, Shaanxi and Xinjiang, China are listed.

Useful references, detailed tropical distribution, and hosts or substrates are provided for each species.

Contributing authors: Shuang-Lin Chen, Lin Guo, Shou-Yu Guo, Ying-Lan Guo, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Xiao-Qing Zhang, Jian-Yun Zhuang, and Wen-Ying Zhuang.

Higher Fungi of Tropical China, edited by Wen-Ying Zhuang

Mycotaxon, Ltd. 2001. Cloth bound, 485 pp., 26 x 18.5 cm. US\$50.00 plus postage. ISBN 0-930845-13-7.

(Please order direct from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 5056 named species belonging to 1192 genera of higher fungi hitherto known from tropical China are listed.

Useful references, detailed tropical distribution, and hosts or substrates are provided for each species.

Contributing authors: Lin Gou, Shou-Yu Guo, Ying-Lan Guo, Xiao-Lan Mao, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Zhi-He Yu, Xiao-Qing Zhang, Jian-Yun Zhuang, and Wen-Ying Zhuang.

Mycotaxon Cumulative Index for Volumes XLI-LX (1991-1996)

Karen D. Gettelman, Richard P. Korf, Susan C. Gruff & Ian F. Korf

Mycotaxon, Ltd. 1998. Softbound, 296 pp., 6x9 inches. \$35.00. Airmail, \$55.00. ISBN 0-930845-07-2.

Mycotaxon Cumulative Index for Volumes XXI-XL (1984-1991)

Richard P. Korf & Susan C. Gruff

Mycotaxon, Ltd. 1991. Softbound, 352 pp., 6x9 inches. \$30.00. Airmail, \$50.00. ISBN 0-930845-01-3.

Mycotaxon Cumulative Index for Volumes I-XX (1974-1984)

Richard P. Korf & Susan C. Gruff

Mycotaxon, Ltd. 1984. Softbound, 232 pp., 6x9 inches. \$17.50. Airmail, \$37.50. ISBN 0-930845-00-5.

[Content continued from inside back cover]

Fibricium gloeocystidiatum (Polyporales, Basidiomycetes), new to Europe

Luigi Arras, Andrea Piga, Annarosa Bernicchia & Sergio Pérez Gorjón 343

Taxonomic revision of the myxomycetes from Cuba deposited in three

reference collections: National Fungus Collections (BPI-USA),

British Museum (BM-UK) and Kew (K-UK)

M. Camino, G. Moreno & A. Castillo 349

Indices & Information

Nomenclatural novelties proposed in volume 100 357

Author index 359

Reviewers 363

Errata 364

From the EDITOR-IN-CHIEF: MYCOTAXON 100 365

Submission to MYCOTAXON 367

MYCOTAXON is published quarterly during the periods of January–March, April–June, July–September, and October–December by MYCOTAXON, LTD., 316 Richard Pl., Ithaca, NY 14850-0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2007 & 2008: In U.S. and possessions, one year, \$330.00; reduced rate for personal subscribers, one year, \$150.00. All foreign subscriptions: Canada/Mexico add \$15, all other countries add \$40 for IMS air mail.

POSTMASTER!

Send address changes to MYCOTAXON, LTD.

P.O. Box 264, Ithaca, NY 14851-0264 USA

- A new and noteworthy species of *Hygrophorus* from Yunnan, China
Fu-Qiang Yu, Guang-Bo Xu & Pei-Gui Liu 169
- New morphological data on *Amauroderma brasiliense* (Polyporales,
Basidiomycota) Gilberto Coelho, Wagner G. Cortez & Rosa T. Guerrero 177
- Aphyllorphoraceous wood-inhabiting fungi on *Abies alba* in Italy
Annarosa Bernicchia, Elena Savino & Sergio Pérez Gorjón 185
- A new species of *Phaeoramularia* on *Ranunculaceae*
Feng-Yan Zhai, Ying-Lan Guo & Yu Li 189
- Two new species of *Agaricus* from the Subantarctic
József Geml, Gary A. Laursen, Harris C. Nusbaum & D. Lee Taylor 193
- Re-examinations of *Botryosphaeriaceae* (Dothideomycetes) from China
on deposit in HMAS Wen-Ying Li & Wen-Ying Zhuang 209
- Did Mussat make new combinations in Sylloge Fungorum XV, 1901?
H.-J. Schroers, G.J. Samuels & W. Gams 221
- A new species of *Conidiobolus* from Great Smoky Mountains
National Park Bo Huang, Richard A. Humber & Kathie T. Hodge 227
- Typification of *Umbilicaria cinereorufescens* Geir Hestmark 235
- Clitopilus amygdaliformis*, a new species from tropical China Zhu L. Yang 241
- First record of the genus *Byssosphaeria* (Pleosporales) in Mexico and
Venezuela Rosario Medel 247
- Phyllachora tengchongensis* sp. nov. and a new record of *Phyllachora*
(Phyllachorales) from China Na Liu & Lin Guo 251
- New records of lichenicolous and lichenized fungi from Turkey
Mehmet Gökhan Halıcı, Mehmet Candan & Ayşen Özdemir Türk 255
- Ripartitella* (Agaricales) from an Atlantic Forest in Pernambuco, Brazil
Felipe Wartchow, Jair Putzke & Maria A. Q. Cavalcanti 261
- Two rare corticioid species with globose spores
María Natividad Blanco, G. Moreno & J. Checa 269
- Type studies on *Chamaeota* species described from China Zhu L. Yang 279
- Mayamontana coccolobae* (Basidiomycota), a new sequestrate taxon
Michael A. Castellano, James M. Trappe & D. Jean Lodge 289
- Vittalia indica* gen. & sp. nov. and *Helicoma indicum* sp. nov. from the
forests of northeastern India Puja Gawas & D.J. Bhat 295
- Anomoloma*, a new genus separated from *Anomoporia* on the basis of
decay type and nuclear rDNA sequence data Tuomo Niemelä,
Karl-Henrik Larsson, Yu-Cheng Dai & Ellen Larsson 305
- New data and localities for *Navisporus* in America
Mabel Gisela Torres-Torres, Laura Guzmán-Dávalos & Leif Ryvarden 319
- Anamorphic fungi from submerged plant material: *Phaeomonilia*
pleiomorpha, *P. corticola* and *Cacumisporium pleuroconidiophorum*
Rafael F. Castañeda Ruiz, Gabriela Heredia Abarca, Rosa Maria Arias,
Masatoshi Saikawa, David Minter & Marc Stadler 327
- Endococcus variabilis*, a new species on *Staurothele areolata*
Mehmet Gökhan Halıcı, Jana Kocourkova,
Paul Diederich & Ahmet Aksoy 337

MYCOTAXON

VOLUME 100 CONTENTS

A tribute to Grégoire Laurent Hennebert and Mycotaxon's 100th volume

Richard P. Korf

South American polypores: first annotated checklist from

Argentinean Yungas

Gerardo L. Robledo & Mario Rajchenberg

Phylogenetic relationships and nomenclature of *Bremiella sphaerosperma*

(*Chromista*, *Peronosporales*)

Hermann Voglmayr & Marco Thines

Five lichens new to Turkey

Kenan Yazıcı & André Aptroot

Typification and description of *Typhula buxi*

I. Olariaga, M.P. Hoyo,

A. Gómez-Bolea & I. Salcedo

Cyathicula brunneospora and *Pirottaea atrofusca*, two new *Helotiales*

from Tian Shan (Kazakhstan)

Markéta Chlebická & Andrzej Chlebicki

Amaurodon sumatranus (*Thelephorales*, *Basidiomycota*), a new species

from Indonesia

Otto Miettinen & Urmas Köljal

Four new Chinese records of *Petriella* and *Pseudallescheria* (*Microascales*)

Guangyu Sun, Junlin Zhang & Rong Zhang

New records of smut fungi from Korea. 1

Cvetomir M. Denchev,

Young-Joon Choi, Seung-Kyu Lee & Hyeon-Dong Shin

New records of smut fungi from Korea. 2

Cvetomir M. Denchev,

Hyeon-Dong Shin & Sung Min Kim

A new record of *Bauhinus piperi* (*Microbotryales*) from Pakistan

Muhammad Asim Sultan, Cvetomir M. Denchev, Ikram-ul-Haq & A.N. Khalid

Rhizomorph anatomy confirms the taxonomic position of *Sclerogaster*

(*Phallomycetidae*, *Basidiomycota*) H. Cléménçon, K. Hosaka & A.F.S. Taylor

Notes on *Amphisphaeria*-like species in HMAS, with a new combination:

Phaeodothis hainanensis (*Pleosporales*)

You-Zhi Wang & Wen-Hua He

Mycoblastus marginatus, a new synonym for *M. affinis* (*Mycoblastaceae*,

lichenized *Ascomycota*)

Toby Spribille & Tor Tønberg

Fruitbodies of *Cenococcum geophilum*

L.M. Fernández-Toirán & B. Águeda

Coprophilous ascomycetes of Thailand

Onuma Jeamjitt, Leka Manoch,

Nipon Visarathanonth, Chiradej Chamswarn,

Roy Watling, George P. Sharples & Anake Kijjoa

Colletotrichum yunnanense sp. nov., a new endophytic species

from *Buxus* sp.

Xiaoying Liu, Xiangming Xie & Junxing Duan

Additions to the lichen mycota of Iran from East Azerbaijan Province

Mohammad Sohrabi & Vagn Alstrup

Taxonomic studies of *Pseudospiropes* from Yunnan, China

Zhi-Qiang Shang & Xiu-Guo Zhang

Two new *Corynespora* species from Jiangsu, China

Zhi-Qiang Shang & Xiu-Guo Zhang

Two new *Alternaria* species from pear fruit

Rodney G. Roberts

[Content continues inside back cover]

